A COMPARATIVE STUDY OF COLLAGEN DRESSING AND SILVER SULPHADIAZINE APPLICATION IN THE MANAGEMENT OF SECOND DEGREE THERMAL BURNS

Dissertation submitted in partial fulfilment of regulation

for

The Award of M.S. Degree in General Surgery (Branch I)

TAMILNADU

DR. M.G.R. MEDICAL UNIVERSITY

CHENNAI - APRIL, 2014.

COIMBATORE MEDICAL COLLEGE HOSPITAL.

CERTIFICATE

This is to certify that this is the bonafide dissertation done by **Dr.Kalaiselvi.P**. and submitted in partial fulfilment of the requirements for the Degree of **M. S. General Surgery**, Branch I of Tamilnadu Dr .M .G .R. Medical University, Chennai.

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DECLARATION

I solemnly declare that the dissertation titled **"A comparative study of collagen dressing and silver sulphadiazine application in the management of second degree thermal burns"** at **Coimbatore Medical College Hospital** was done by me from October 2011 to October 2013 under the guidance and supervision of Professor **Dr.D.N.Renganathan,M.S.,** This dissertation is submitted to **Tamilnadu Dr . M. G. R. Medical University** towards the partial fulfilment of the requirement for the award of M.S Degree in General Surgery (Branch I).

Place: Coimbatore

Date : **Dr. P. Kalaiselvi**

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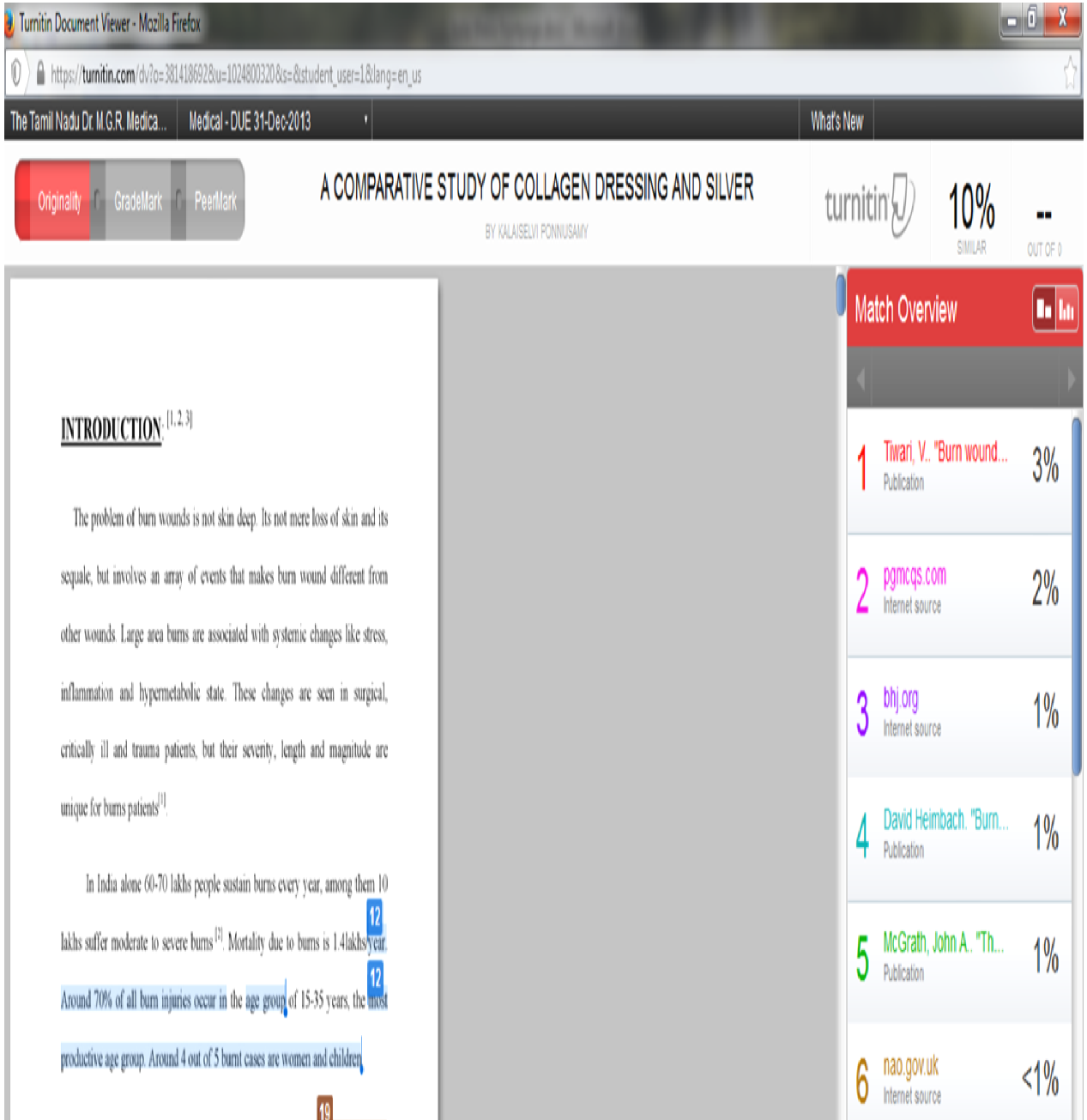
INTRODUCTION: [1, 2, 3] The problem of burn wounds is not skin deep. Its not mere loss of skin and its sequale, but involves an array of events that makes burn wound different from other wounds. Large area burns are associated with systemic changes like stress, Inflammation and hypermetabolic state. These changes are seen in surgical, critically ill and trauma patients, but their severity, length and magnitude are unique for burns patients[1]. In India alone 60-70 lakhs people sustain burns every year, among them 10 lakhs suffer moderate to severe burns [2]. Mortality due to burns is 1.4lakhs/year. Around 70% of all burn injuries occur in the age group of 15-35 years, the most productive age...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CONTENTS

ABSTRACT

BACKGROUND AND OBJECTIVES:

In India alone, 60 – 70 lakhs people sustain burns every year. Mortality due to burns is 1.4 lakhs/year. Around 70% of all injuries occur in the age group of 15 – 35 years, the most productive age group. The most logistic approach to burn wound would be a wound cover until such time the body is able to synthesize a cover of its own. In a tropical country like India, closed dressings get easily infected and open dressings get dried up soon. Collagen dressings provide the most physiological interface between the wound surface and the environment. Hence I chose to study the merits and demerits of collagen dressing over the conventional silver sulphadiazine ointment application.

METHODS:

70 patients with second degree thermal burns less than 20% TBSA, getting admitted in the General Surgery and Pediatric Surgery Departments of Coimbatore medical college hospital were enrolled for the study from October 2011 to October 2013. Surface area of burns was assessed by “Wallace rule of nine”. The patients were selected based on inclusion and exclusion criteria and randomly assigned to silver sulphadiazine and collagen group. All patients were treated with analgesics, intravenous fluids and antibiotics. Wound washed thoroughly and dried. Both silver sulpha diazine ointment was applied and left open or collagen sheets applied.

RESULTS:

In this study thermal burns were more common in females between 21-35 years of age. Between the silver sulphadiazine and collagen group, the average pain score (over the scale of 3) on day 1 was 2.19 v/s 1.11. and on day 2 was 1.96 v/s 1.04. The average duration of wound healing was 17.48 and 13.6 days for silver sulphadiazine and collagen groups respectively. Both pain score and wound healing were found to be statistically significant (P value <.01).

The incidence of wound infection, need for split skin graft, development of contractures and hypertrophic scars were found to be low in the collagen group. However they were found to be statistically insignificant (P>.05).

INTERPRETATION AND CONCLUSION:

Collagen application is better than silver sulphadiazine application in the management of burn wounds owing to its better pain relief, rapid wound healing, need for application of dressing only once, early ambulation and early identification of wound infection due to its translucency.

Keywords: collagen sheets, collagen application, silver sulphadiazine application, burn wound.

INTRODUCTION: [1, 2, 3]

The problem of burn wounds is not skin deep. Its not mere loss of skin and its sequale, but involves an array of events that makes burn wound different from other wounds. Large area burns are associated with systemic changes like stress, inflammation and hypermetabolic state. These changes are seen in surgical, critically ill and trauma patients, but their severity, length and magnitude are unique for burns patients[1].

In India alone 60-70 lakhs people sustain burns every year, among them 10 lakhs suffer moderate to severe burns [2]. Mortality due to burns is 1.4lakhs/year. Around 70% of all burn injuries occur in the age group of 15-35 years, the most productive age group. Around 4 out of 5 burnt cases are women and children.

According to WHO, women in the Southeast Asia account for 27% of global burn deaths and nearly 70% of the burn deaths in that region. The higher incidence in developing countries is due to illiteracy, poverty and low safety consciousness among the public.

The Union ministry has prepared 2933 crore rupee program against burn injuries. The National Programme for Prevention of Burn Injuries (NPPBI)[3] was launched in the current five year plan with 3 components –

1) Prevention programme 2)Burn injury management programme 3)Burn injury rehabilitation programme.

Accidental burns occur due to cooking in open fire, cooking on floor, kerosene stove and not following the necessary precautions at home and work spot.

Non-accidental burns occur as a result of bride-burning, personal disputes and child abuse.

The most logistic approach to burn wound is a wound cover until such time the body is able to synthesize a cover of its own. Traditional burn wound management involves cleaning, debridement, and provision of a moist environment to aid wound healing. Ideal dressing material act a barrier to bacteria and environmental contaminants, medium for exchange of gases, provide a moist environment and prevent water and electrolyte loss from the wound surface. Research in the field of wound dressing has resulted in the invention of biological and synthetic dressings. Earlier, human amnion was extensively used but has become less popular because of the risk of infection. Continued research in the field of burn dressing has led to the invention of collagen based dressings.

70 patients with II degree burns admitted in Government Coimbatore medical college hospital are selected based on the inclusion

and exclusion criteria and assigned randomly to silver sulphadiazine or collagen application. These patients are assessed for pain perception, wound infection, day of near complete epithelialisation and cosmetic outcome.

REVIEW OF LITERATURE: [4, 5, 6, 7, 8]

Fire is existing in this world even before the origin of mankind. Hence thermal burns should have been as old as mankind.

The first evidence of treatment of burns is seen in the cave paintings of Neanderthal man, which is over 3500years old.

The Egyptian Smith Papyrus of 1500BC advises a salve of resin and honey for treating burns. In 600BC, the Chinese used tea extracts on burns.

Around 400BC, Hippocrates described the use of rendered pig fat and resin which was incorporated in bulky dressings. Wine and vinegar were also used. Rhases, the Arabian physician recommended the use of cold water for pain relief.

Ambroise Pare (1510-1590), treated burns with onions and recommended early burn wound excision.

Guilhelmus Fabricius Hildanus, in 1607, published De Combustionibus which dealt with the pathophysiology of burns and treatment of contractures.

In 1797, Edward Kentish described pressure dressings as a measure to relieve burn pain and blisters.

In the early 19th century, Dupytren reviewed 50 burn patients treated with occlusive dressings and arrived at a classification based on burn depth that is used even today.

In 1921, Frank P Underhill, Professor of Pharmacology at Yale, studied 20 burn patients and found that blister fluid was composed of fluid similar to that of plasma. He suggested that death in burn patients was due to loss of fluid and not from toxins – a general belief at that time.

In 1944, Lund and Browder developed diagrams to assess the area of burns.

Kyle and Wallace showed that the heads of children were relatively larger and modification for fluid replacement formula in children. After cutaneous burns, fluid accumulates not only in the interstitial space but also in the intracellular space due loss of sodium-potassium pump. Finally, hypovolemic shock ensues if the lost fluid is not replaced. Also protein given in the first 24hours, will leak through the capillaries and exacerbate the fluid loss. Evan's, Brooke's, Parkland's, Monafo's, SBH-Galveston formulas were all evolved for the management of fluid replacement. It was also suggested that fluid management should begin as early as 2 hours post-burn to have maximum benefit.

Dr. Truman G Blocker, during the Texas City disaster that involved more than 3000 casualties, when two freighters loaded with ammonium nitrate fertilizer exploded on April 16, 1947, demonstrated to this world the value of team approach to burn care. He also advocated “cleansing, exposing the burn wounds to air and feeding them as much as they could tolerate”. In 1962, the first burn institute for children in Galveston, Texas, was established, because of his commitment towards burned children.

In 1954, Jackson and colleagues advocated excision and grafting of burns ranging from 3% to 30% TBSA. In 1960s, Janzekovic followed the method of removing deep second degree burns by tangential excision using simple knife, between day 3 and 5, and covered with auto grafts. She treated 2615 patients by this way and observed that all patients were back to work in a fortnight. During 1970s and 1980s, Dr John Burke, followed excision to the level of fascia in children with burns over 80% and found a decrease in mortality rate.

Advances in skin grafting have paralleled the advances in burn wound excision. In 1930s, reliable and reproducible instruments for split thickness graft were designed. In 1936, Hamby’s knife was developed. It was the first dermatome with reproducible results but was cumbersome. Padgett developed drum dermatome and an adjustable dermatome with good cosmetic results. In 1964, Tanner and his associates introduced the

concept of meshing of grafts. Wesley Alexander introduced the method of widely meshing auto grafts and covering it with allograft from cadavers. In 1981, Jack Burke, invented an artificial skin named Integra, which has tremendous advantages in massive burns, where grafting is not possible.

The hyper-metabolic response to extensive burns was studied as early as 1970s by Wilmore and found to be due to excess catecholamines, cortisol and glucagon resulting in glucose intolerance and insulin resistance. The heat was produced by biochemical inefficiency, defined by Robert Wolfe as futile substrate cycling.

Wilmore also advised high caloric feeds around 8000kcal/day. William P Curreri, devised a formula based on weight and surface area for calorie requirements in burns. Herndon et al , clearly proved that parenteral nutrition increased mortality and recommended enteral feeding as a standard care for burn patients. Early enteral feeding also maintains gut mucosal integrity, prevents transluminal migration of gut pathogens and prevents stress ulcers.

Burn wound dressing:

The first dressing ever used might have been a leaf of a herb or tree. Certain substances were found to have better results and more comfort than others. Edward Davidson introduced the use of tannic acid spray in

1925. It caused formation of eschars, which were then believed to reduce fluid loss and reduce pain. However, its use was later abandoned as it was proved to be toxic to patients. Aldeidge suggested the use of Gentian violet, which had bacteriostatic properties. Later, 5% AgNO3 was added as an escharotic. This treatment continued till World War II. In 1942, Allen and Koch introduced the use of petroleum gauze pressure dressings with strict immobilization. These dressing did not address the fluid loss occurring through the wound. Yet, this dressing was popular during World War II.

With the advent of Silver containing topical anti-microbials, burn wound sepsis reduced tremendously. In 1965, Carl Moyer used 0.5% Silver Nitrate soaks for burn wounds. Germans used Mafenide acetate in World War II for open wounds. This was adapted by the microbiologist Dr. Robert Lindberg and surgeon John Moncrief for treating burn wounds. This antibiotic was effective against a wide range of pathogens and would penetrate eschar. Being a carbonic anhydrase inhibitor, it caused metabolic acidosis, compensatory hyperventilation and pulmonary edema. But it still holds good for invasive burn wound sepsis.

Simultaneously, Charles Fox in New York, formulated Silver sulfadiazine cream which has a wide spectrum of activity but without

systemic side effects. Nystatin in combination with Silver sulphadiazine was also introduced to control Candida in burn wounds.

Burn wound dressing can be broadly classified as

1) Conventional dressings
    a) Simple- one substance serving all purpose
    b) Compound – more than one substance each serving a specific function
2) Biological dressings

    Consists of adherent collagenous dermal surface and keratinized epidermis

    a) Allograft
    b) Xenograft
3) Synthetic dressings which are man-made.

Conventional Dressings [7]:

These are the most commonly used dressings for all types of wounds. The material used is gauze which is one of the most satisfactory absorbent. Tulle gauze is a paraffin impregnated wide mesh gauze. It is made non-adherent by its greasiness but excessive greasiness will interfere with fluid absorption. Infection through open network of gauze is another disadvantage.

To overcome this Wong in 1980 introduced antibiotic impregnated tulle guaze.

Biological Dressings:

In areas where the biological dressings get adhered to the wound bed the bacterial load decreases. In areas where the dressing is non adherent sub-membrane suppuration occurs. They prevent evaporative water and heat loss and prevent contamination of wound bed. They also prevent drying of burn wounds. They decrease wound pain facilitating early ambulation.

Biological dressings should not be applied to superficial or deep burns prior to removal of debris and to full thickness burns prior to eschar separation and debridement. It should not be applied to wound having bacterial population more than 1lakh organisms per gram of tissue.

Basil A Prutt Jr. and Normal Levine studied about biological dressings and concluded that if biological dressing if applied to heavily contaminated wound marked submembrane bacterial proliferation occurs leading to suppuration. In such instance, partial thickness burn may become full thickness and in case of full thickness burns, it may extend into the surrounding unburned area.

Allograft[7,9,10,11]:

It is a human graft obtained from living or recently deceased donor. Allografts are used for covering full thickness burns after separation of eschar and for immediate covering for superficial second degree burns. After application of allograft there is an evidence of graft vascularisation within 48-72 hours. This enables excellent take of autografts skin applied to the same wound after removal of allograft skin. The supply of allograft does not always match its demand. It needs storage in a refrigerator and has a short shelf life of 7-10 days when stored at 4 ^{0}C. When the thickness of the graft is more than 1mm the lyophilized material undergoes epidermis separation causing exposure of dermis. The exposed dermis dries and rapidly sloughs off the wound.

Amnion which was used as a biological dressing was non-expensive and readily available. Covering amnion with occlusive dressing prevents desiccation and rapidly sloughing of the graft. It increases the capillary density of underlying wound bed. The disadvantage with amnion is that it carries the risk of HIV and hepatitis infection.

Xenograft [7, 9, 10, 11]:

Pig skin was popularized in 1960 and is the most common xenograft used. Its readily available, easily stored and sterilized. Though different at

microscopic level, with regard to adherence of collagen, texture and collagen content both human and pig skins are comparable. Application of pig skin requires immunosuppresion and reconstitution in normal saline or Ringer lactate solution. Reconstitution takes half an hour which may cause considerable delay in management of burn wounds.

Synthetic Dressings [7, 11]:

In 1975, Levine et al, excised 60% of the skin in murine model and observed uniform mortality in both groups irrespective of whether the animal was left uncovered or covered with impermeable membrane. Coverage of such wounds with allograft or synthetic skin substitute dramatically improved survival rate. Over 30% of the murine models survived. This study rekindled interest towards synthetic skin substitutes.

Polyvinyl chloride films:

The earliest synthetic material used was polyvinyl chloride film. It was thin and permeable to water vapour, oxygen and carbon dioxide. The application caused dramatic pain relief. But submembrane suppuration was of major concern. The suppuration converted partial thickness burn to full thickness. This effect of microorganisms was observed by Harrison et al in 1986.

Hydron Films:

Hydron films are membrane dressings made of 2 –hydroxyl- ethyl-methacrylate polymerized with polyethylene glycol. 2- hydroxyl-ethyl-methacrylate and polyethylene glycol are spread on the burn wound to form a membrane (Harrison et al,1966)

In 1980,Warren and Snellen used Hydron films in series of burn patients with less than 15 % TBSA. In their study they found out that when applied over extensor surface area, the dressings easily lifted off. In many patients the dressings lost its integrity or required complete reapplication. Submembrane suppuration occurred, leading to conversion of partial thickness to full thickness injury. But 80% study population reported reduction in wound pain. In 1978, Nathan et al did invitro studies using agar plates impregnated with bacteria and covering with hydron dressings. They demonstrated decreasing in bacterial count.

In 1982, Nathan et al studied using on rat wth burns involving 10% TBSA. He demonstrated hydron films acted as barrier against bacterial contamination.

Upon adding topical antibiotics over the dressings the antibacterial activity was remarkably improved.

Fibrin Films [12]:

In 1974, Nishi et al, reported use of fibrin films in 333 burn patients. Fibrin films are unilaminate wound dressings. It has low antigenicity and functions like serum crust. Investigators recommend fibrin films to be covered with gauze dressings to maintain adherence to the wound. These films were found to have reduced healing time in partial thickness burn patients.

Opsite Films [13]:

Opsite films are made of elastomeric polymethyl. These films are recommended for partial thickness burns but not for full thickness burns. In 1975, James and Watson observed that these films significantly reduced wound pain and promoted fasted healing (10 +/- 5 days). The major drawback is its poor water permeability. As a result fluid accumulates between the burn tissue and the dressings. This is especially proved in case of scalds where large volumes of exudates are formed.

Collagen Films [7, 8, 11, 14, 15]:

Collagen is an attractive skin substitute for two reasons: 1. It can be isolated from other species. 2. It can be manufactured in large amount. The tensile strength of collagen is improved by physical and chemical methods thereby preventing fragmentation. It has low antigenicity and has

haemostatic property. It is available in various forms such as powders, foams, films are bound to other materials as part of composite dressings.

Initial adherence of collagen to the wound is fibrin dependent process. Adherence of particular membrane to the skin is measured using a device which exerted tension to the membrane at right angles to the skin surface from the weights required to loosen the graft. In 1975, Tavis et al[16], demonstrated by this method that collagen films exerted greater adherence after 5 hours and 72 hours in contrastive in auto graft, allograft ,xenograft and silicon membranes.

In 1977, Lamke et al [17], measured the water vapour permeability of various thickness of collagen films and demonstrated almost complete permeability in films upto 1mm thick. This property enables impregnation of antimicrobial agents along with collagen films thereby reducing wound infection.

In 1978,Gupta et al[18], conducted studied on guinea pigs. They created raw area on the back of guinea pig artificially and covered them with collagen sheath. The collagen was obtained from the intestines of freshly slaughtered cattle. He observed the wound clinically as well as microscopically.

By the 4th week complete epithelialisation occurred and there was diffuse invasion of sheets by fibroblast, chronic inflammatory cells and capillaries.

By 6th week, he observed the collagen was completely replaced by epithelial cells, fibroblasts and new blood vessels. He applied collagen sheet for superficial and deep burns. In superficial burns, epithelialisation occurred by end of 2nd week.

In deep burns by 7th day the sheet was swollen and got disintegrated leaving unhealthy granulation tissue. They observed immediate and tremendous pain relief during wound dressing.

In 1984, Frank DH[19], studied wound contraction in rats after applying Biobrane.raw area was artificially created over the back of the rat and covered half the population with Biobrane (Bilayer sheet with silicon on the outside and nylon with collagen on the inside) and subjected the rest to exposure method. He demonstrated a difference in the rate of wound contraction between the two groups.

In another study, Frank DH[20], proved that Biobrane can withstand bacterial contamination after adhering to the wound surface.

In 1987, Purdue et al[21] , conducted a multicentric trial comparing Biobrane with human cadaver allograft(frozen). The study concluded that

with respect to dressing changes, wound infection and take of the graft, there was no significance between biobrane group and allograft group. Because of the paucity of cadaver graft compared to the easy availability of the Biobrane, Biobrane dressing can be considered superior.

In 1988, Gerdling et al[22] , compared biosynthetic skin substitutes and silver sulphdiazine. They concluded that biosynthetic skin substitutes superior to silver sulphadiazine with regard to pain relief and wound healing. They suggested wound should be fresh, free of debris with moist sensate surface that demonstrate capillary refill. The wound has to be inspected daily for any serous collection. Presence of non adherence of the skin substitute at any time beyond 48 hours is considered an indication for removal of the skin substitute.

In 1988, Nowicki CR et al[23], compared Biobrane, allograft and pig skin with respect to nursing care and patient compliance. The study concluded that in selected population Biobrane is superior to allograft with regard to reduction in pain submembrane suppuration and adherence to the wound. The Biobrane group was ambulant earlier requiring nursing care only for shorter duration.

In 1990, Gerdling et al[24], studied patient with partial thickness burns less than 10% TBSA. The study was conducted on outpatient basis comparing Biobrane application and silver sulphadiazine application. They

concluded Biobrane group had lower pain score and required less amount of analgesics. The cost of treating with Biobrane was lower significantly of treating with Biobrane was lower significantly than with the silver sulphadiazine. However infection rates were similar in both the groups.

In 1990 Yang JY[25], conducted a study with young collagen wettable membrane (YCWM) on burn wounds in 59 patients. They found certain favorable characteristics like negligible antigenicity, pain relief and semi-transparency. Semi transparency helped in identification of any submembrane collection of serous fluid and to assess submembrane suppuration earlier. The young wettable collagen membrane was considered useful for coverage of non-infected fresh partial thickness burns.

In 1992, Gao et al [26], conducted a study with porcine dermal collagen on artificially burnt rats and demonstrated that it increased the rate of wound healing. In another study, comparing collagen dressing and petroleum gauze dressing at donor sites of burn. They concluded that collagen group showed early epithelialisation (10.3 days) in contrast to the petroleum gauze dressing (14.5 days).

In 1995, Sakiel S and Grzybowsky J[27], compared bovine collagen with porcine collagen in partial thickness burn wound. The healing time

with collagen was 11+/- 3.4 days. The healing time with porcine skin was longer 12 +/- 4.9days.

In 1999,Demiling et al[6], compared bioengineered skin substitute (transcyte) and topical antibiotics in partial thickness facial burns. The parameters studied were daily burn care time, pain score (0 – 10 scale) and healing time. Marked reduction in wound care time (0.35+/-1 v/s 1.9 +/- 0.5 hours), pain (2+/-1 v/s 4+/-2) and healing time (7+/-2 v/s 13+/-4days) were observed. They inferred bioengineer skin substitutes significantly increases the rate of wound healing in partial thickness facial burns.

In 1999, Barret et al[28], did the comparative study between Biobrane and 1% silversulphadiazine in second degree paediatric burns. They inferred that the Biobrane group experienced less pain and required less analgesic. The time required for ambulation, length of hospital stay was significantly less in the Biobrane group. The time required for complete epithelialisation with Biobrane application was 9.7+/- 0.7days in contrast to silver sulphadiazine application which was 10.1+/- 0.6 days.

In 2001, Delatte et al [29], applied B glucagon collagen on partial thickness paediatric burns. The study was conducted on 225 children during a study period of 2 years. At the end of the study, they observed that the patients required less pain medications, had faster healing and better patient compliance as dressings are not required.

In 2003, Wisser et al[30], used Integra (collagen based substitute) demonstrated successful wound management in a 19 year old patent in 76% TBSA.

In 2005, Klein et al [31] , studied using Integra on facial burns. They observed that the neodermis so produced was as supple as that would form after thick auto graft. However autograft remains the gold standard coverage for facial burns. Whenever autograft was not available due to extensive burn injury, Integra remains a good alternative.

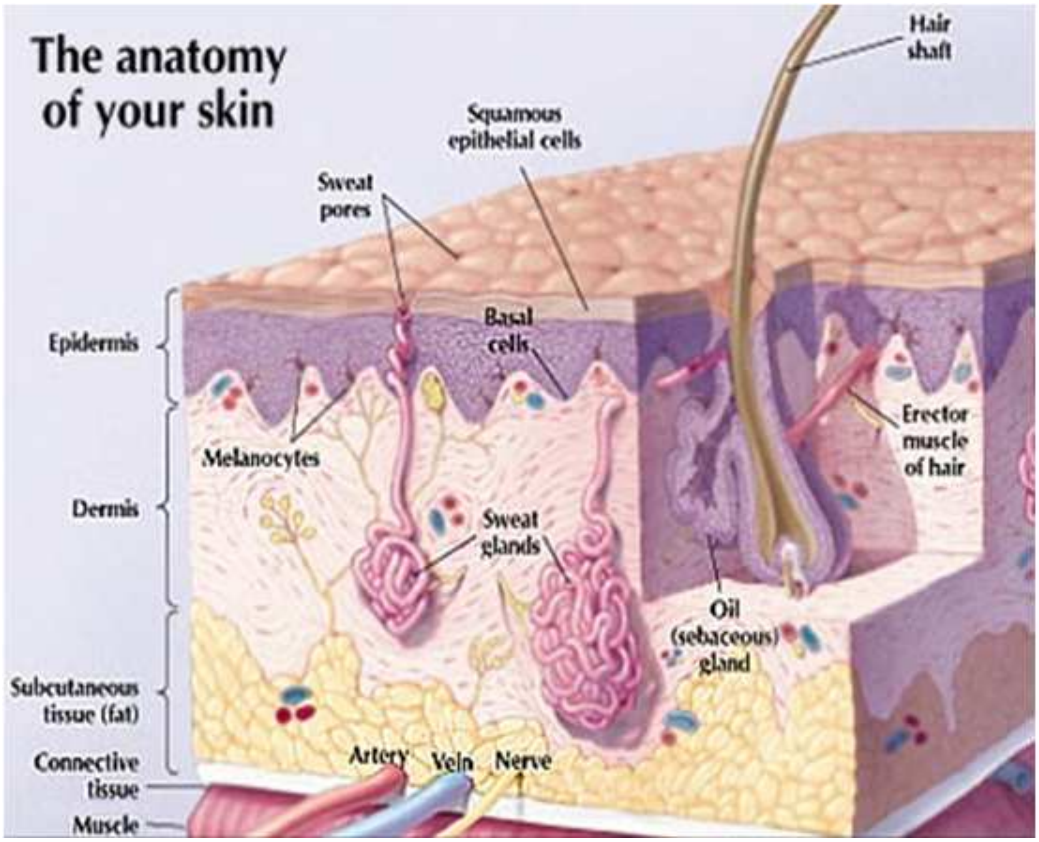
ANATOMY AND PHYSIOLOGY OF SKIN

COMPONENTS OF HUMAN SKIN [32, 33]:

Skin is the largest organ of the body. For a 70kg individual, surface area approaches 2 m^2. Skin consists of epidermis and dermis.

Epidermis:

- It is composed mainly of keratinocytes.
- It is typically 0.05 – 0.1mm in thickness.
- Cells in the basal layer divide to form the spinous layer.
- Cells in the spinous layer move outwards progressively differentiating to granular layer and stratum corneum.
- Cells in the stratum corneum have lost nuclei and cytoplasmic organelles.
- The cellular progression from the basal layer to the skin surface takes about 30 days.
- Human skin contains pilosebaceous follicles and sweat glands. The hair follicles are lined by, epithelium that are continuous with the superficial epidermis but which also envelop a small papilla of dermis at their base. Also derived from the epidermis and directly to the skin surface are the eccrine sweat glands.



Epidermo-dermal junction:

The epidermis is attached to the dermis via a complex network of proteins and glycoprotein that extend from inside basal keratinocytes into the superficial dermis. The dermal-epidermal junctional components contribute to cell migration that is essential for wound healing.

Dermis:

The dermis is a supporting matrix or ground substance in which polysaccharides and proteins are linked to produce macromolecules that have a remarkable capacity for retaining water. The thickness of dermis

varies from <0.5mm to more than 5mm. Two principal types of protein fibre seen are the collagen and elastic tissue.

Collagen is the major extracellular matrix protein comprising 80-85% of the dry weight of the dermis. 29 different collagen tissues have been identified. The main interstitial dermal collagens are typeI &III. The basement membrane collagen is type IV. Collagen fibres are extremely tough and provide skin with its tensile strength.

Elastic fibres account for 2-4% of extracellular matrix in the dermis which give elasticity and resilience to the skin.

Between the dermal collagen and elastic tissue is the ground substance glycosaminoglycan, which has a vital role in maintaining hydration.

The dermis has a rich vascular supply although no vessels pass through the dermal and epidermal junction. There is superficial and deep vascular plexus.

FUNCTIONS OF THE SKIN:

1) Mechanical barrier against the external environment.
2) The stratum corneum restricts water loss from the skin.
3) Defensins and Cathelicidins are keratinocyte derived endogenous antibiotics that provide an immune defense against bacteria, viruses and fungi.
4) Subcutaneous fat – contains trauma, insulates the body, act as a caloric reserve and leptin released from here, acts on hypothalamus and regulates hunger.
5) Synthesis of vitamin D.
6) Langerhan cells are sentinel cells that survey the epidermal environment.
7) Melanin protects the skin from DNA damage caused by UV rays.
8) An important function of skin is thermoregulation.

Vasodilatation or vasoconstriction of blood vessels in the deep or superficial plexus helps regulate heat loss. Eccrine sweat glands produce about one liter of sweat per hour during moderate exercise.

PATHOPHYSIOLOGY OF BURNS [4]:

Burn injury causes extravasation of plasma into the wound and surrounding areas leading to shock, that is quite similar to hemorrhagic hypovolemia. However, the hematocrit is low in hemorrhagic shock, whereas it is elevated in burn patients owing to hemoconcentration.

As with other hypovolemic shock, decrease in plasma volume, cardiac output and increase in peripheral resistance occurs in burns. Treatment is by restoring the vascular volume by fluid resuscitation. Fluid resuscitation is however complicated by development of burn wound edema.

Under normal physiologic conditions, blood filtration pressure causes filtration of fluid from the capillaries into the interstitium. The fluid is partly reabsorbed by the capillaries at the venular end, while the rest is removed by the lymphatic system. The fluid transport across the microcirculatory wall is governed by the Landis-Starling's equation.

Edema develops when the lymphatic drainage does not keep pace with the amount of fluid filtered out across the microvessels. The edema develops extremely rapid, that it can double in an hour after injury.

Burn wound edema [4]:

Following are causes of burn wound edema:

1).The predominant mechanism is the generation of strong negative pressure in the interstitial space which is in part due to degeneration of collagen and to changes happening to the compliance of burnt tissue.

2). the increase in capillary hydrostatic pressure.

3). the increase in capillary permeability, leading to protein leakage and increased interstitial oncotic pressure.

Burn edema is unique because it is the edema where the Starling's forces act in a direction that causes fluid filtration across the capillaries.

Mediators of burn injury:

Understanding of the mediators involved in burns is of great clinical relevance as development of pharmacological agents that inhibit these mediators can help reduce burn edema and shock.

The circulating mediators profusely increase vascular permeability and altered membrane function leading to interstitial and intracellular edema. They also retention of salt and water, vasoconstriction and impaired cardiac contractility as a result there is hypovolemia, increased systemic vascular resistance, reduced cardiac output, hypoperfusion and

metabolic acidosis without resuscitation the process may end in acute renal shutdown, cardiovascular collapse and death.

SYSTEMIC EFFECTS OF BURN INJURY [1]:

Effect on metabolism:

Severe burns is followed by a period of hypermetabolism which is characterized by a hyperdynamic circulatory response, with rise in body temperature , excessive breakdown of glucose, protein, fat and futile substrate cycle. Such hyperdynamic circulatory response is seen in all critically ill patients, but the intensity and duration are unique for burn patients.

Changes in glucose metabolism:

- Increased gluconeogenesis and glycolysis by 250%.
- Development of post receptor insulin resistance
- Thereby, there is increased glucose delivery to tissues but with reduced glucose oxidation.

Changes in protein metabolism:

- Following burn, muscle protein is degraded much faster than it is synthesized. Negative nitrogen balance sets in.
- With 10% loss, of mean body mass immune function get impaired.

- With 20% loss, wound healing is impaired.
- With 30% loss, the patient is susceptible for pressure sores and pneumonia.
- With 40% loss, death may ensue.
- Pediatric patients will develop significant retardation in growth, even upto 2 years post injury.

Changes in fat metabolism:

There is decreased absorption of fatty acids from the gut mucosa owing to increase in gut permeability.

Effect on cardiovascular system:

Decrease in plasma volume, increase in blood viscosity, increase in peripheral vascular resistance and myocardial depression, all result in reduced cardiac output.

Effect on renal system:

Reduced blood volume triggers Renin-Angiotensin-Aldosterone system and increases ADH which result in decreased renal blood flow and renal failure.

Effect on GIT:

- Increased apoptosis leading to small bowel mucosal atrophy.
- Diminished absorption of glucose, aminoacids and fatty acids.
- Increased intestinal permeability to macromolecules.

Effect on immune system:

- The depression in immunity is directly proportional to the percentage of burns.
- Neutrophils count is initially increased, but decrease after 48 hours.
- There is impairment of macrophage function and cytotoxic T-lymphocytes.

LOCAL EFFECT OF HEAT ON SKIN [4]:

The temperature to which the tissue is exposed and the duration of exposure are the two important factors that decide the extent of tissue damage.

At temperatures between 40 and 44^0 C, various enzymes begin to malfunction and protein denaturation occurs. One of the enzymes is the Na^+/K^+ ATPase present in the cell membrane. As a result there is accumulation of Na^+ inside the cells, resulting in cell swelling.

At temperatures above 44^0C, the cell's inherent repair mechanisms are exhausted resulting in cell death. Alterations in cell membrane and damage incurred by free radicals are the prime reasons for cell death. If the heat process is suddenly withdrawn, the damage continues until the temperature is brought back to normal by the cooling process. Therefore, if the cell is rapidly cooled, it obviates significant amount of cell damage and helps in cell survival.

The area of cutaneous injury can be divided into three zones- **Jackson** (1959) has described **THREE ZONES**[1] in the damaged burned tissue

1**. Central zone of coagulation** – This is the central part of burns with complete coagulative necrosis. This tissue is irreversibly damaged at the time of injury.

2. Zone of stasis– Zone of stasis immediately surrounds the zone of coagulation. This zone has incurred moderate degree of insult. The circulation is sluggish in this zone, due to vessel damage and leakage. Depending on the wound environment, it can either proceed to coagulation or recover completely. The effective fluid resuscitation and wound care helps to prevent this zone from progressing to necrosis.

3. Zone of hyperemia – This is peripheral to zone of stasis. It is the result of intense vasodilatation as is seen in inflammatory phase after the trauma. This eventually recovers completely. It is from this tissue the healing process begins.

Healing of burn wound depends on the DEPTH OF BURNS [1]. Burn wounds can be classified according to involvement of skin and deeper tissues.

BURN WOUND CLASSIFICATION:

Burn wounds can be classified according to depth, etiology or severity.

CLASSIFICATION BASED ON DEPTH [1]:

1. First-degree burns or epithelial burns:

Involve only the epidermis.

2. Second-degree burns:

Involving epidermis and variable thickness of dermis. This is again divided into

2a).Second-degree superficial burns – where vesication and inflammation is seen in skin as only papillary dermis is involved.

2b).Second-degree deep -eschar formation is seen as it involves deep reticular dermis.

3. Third-degree burns:

Also known as full thickness burns - eschar formation is present in these burns.

4. Fourth degree burns:

Injury through the skin, subcutaneous fat and into the underlying muscle or bone.

CLASSIFICATION BASED ON MECHANISM OF INJURY[1]:

1. Scalds
2. Fire
3. Contact burn
4. Electrical burn
5. Chemical burn
6. Radiation burn

Scalds can be caused by hot liquids like water, tea, curry, cooking oil or hot steam. Fire burns can be either flash or flame burns. The mechanism of injury in general can be used as a prognostic marker – electrical and flame burns usually require care in a hospital setup.

CLASSIFICATION BASED ON SEVERITY:

American Burn Association Severity Classification[4]:

---Minor, moderate and severe burn

Minor Burn :

1. Adult with burns <10% TBSA
2. Young or old with burns < 5% TBSA
3. Full thickness burn <2% TBSA

Moderate Burn :

1. Adult with burns 10-20% TBSA
2. Young or old with burns 5-10% TBSA
3. Full thickness burns 2-5% TBSA
4. High voltage injury
5. Possible inhalation injury
6. Circumferential burn
7. Other health problems

Major Burn :

1. Adult with burns >20% TBSA
2. Young or old with burns >10% TBSA
3. Full thickness Burns >5% TBSA
4. High voltage burn
5. Known inhalation injury
6. Significant burn to face, joints,hands or feet
7. Associated injuries

WOUND HEALING IN BURNS:

The phases of wound healing are same as for all types of wound but the only difference being the duration of each phase.

I.INFLAMMATORY OR REACTIVE PHASE:

It has two components

a).**Vascular response:**

Vasodilatation leads to increased capillary permeability and massive extravasation of plasma

b).**Cellular response**:

Neutrophils and monocytes are the first cells to migrate to the site of inflammation. Later neutrophils decrease in number and are replaced by macrophages. Chemotaxis of these cells are mediated by substances released from mast cells like TNF, histamine, proteases, leukotrienes and cytokines. As a result of this response phagocytosis and cleaning of death tissue occur.

II. PROLIFERATIVE OR REPARATIVE PHASE:

In partial thickness burns, epithelialisation starts by migration of keratinocyte from the viable skin appendage. It covers the wound after 5-7

days. The basement membrane zone then forms between the epidermis and dermis. Angiogenesis and fibrogenesis helps in reconstruction of dermis.

III. MATURATION OR REMODELING PHASE:

There is laying down of collagen and elastin around epithelial, endothelial and smooth muscle cells as extracellular matrix. Later, the fibroblast becomes myofibroblast which is responsible for scar contraction.

In deep second degree and third degree burns, if left to heal on its own, the maturation phase may take years to heal. Such wounds heal by hypertrophic scarring and contractures.

Hyperpigmentation is due to overactive melanocytes and is seen in superficial burns. Hypopigmentation is due to loss of melanocytes and is seen in deep burns. In first degree and second-degree superficial burns, healing is by primary intention. In second degree deep burns, third degree burns healing is by secondary intention.

ASSESSMENT OF BURN WOUND:

ESTIMATION OF BURN DEPTH [1, 4]:

Clinical judgment by an experienced burn care physician remains the gold standard method of estimation of burn depth. Burn depth assessment is crucial in planning the management of burn patients because, certain wounds require operative intervention like burn wound excision and grafting while others need only local treatment. However burn wounds especially partial thickness burns tend to evolve over 48 to 72 hours, and ability to predict healing capacity of the wound is limited, even by experienced persons.

First degree burns:

These wounds have intact epidermal barrier. They are painful, erythematous and blanch on touch. Eventually it heals within 7 days without leaving a scar. Application of topical soothing salves and oral analgesics suffice these kinds of burns.

Second degree burns:

All second degree burns have some degree of dermal damage and are also known as partial thickness burns.These burns are further classified as superficial and deep second degree burns.

Superficial second degree burns often blister. They are erythematous, blanch on touch. They are painful because of the survival of nerve endings in the superficial and mid dermis. These burn wounds spontaneously reepithelialize from the rete ridges, sweat glands and hair follicles in 10-14 days. Upon healing, these wounds show little scarring, though some amount of pigmentary changes can occur. Unless complications occur, these wounds can be managed by burn wound dressing and correction of hypovolemia. However, it is this type of burn that is prone for converting into deep burns owing to significant amount of zone of stasis underlying the superficial zone of necrosis.

Deep second degree burns, often extend into the reticular dermis. Heat kills the nerve endings, making these wounds relatively insensate. But remain painful to pinprick. They are pale, mottled and do not blanch on touch. Pressure sensation remains because the pressure receptors are deeply seated. Blistering is usually absent because the burn wound edema is unable to lift the thick overlying eschar. And, for all means these wounds are treated like full thickness burns. These types of wounds heal in 2 – 5 weeks with severe scarring due to loss of dermis. Healing is by reepithelialisation from the keratinocytes of hair follicles and sweat glands.

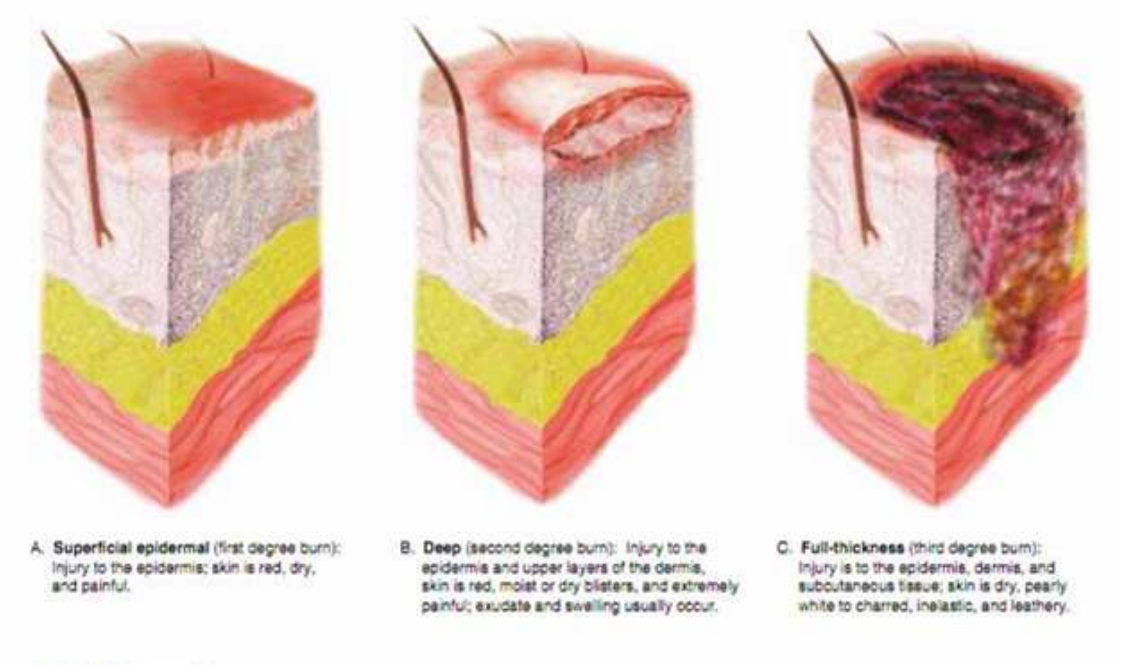
Third degree burns:

These are painless due to destruction of nerves. They are covered by black, white or cherry red, hard leathery eschar. No epidermal or dermal appendages remain, hence healing occurs from the wound edges.

Deep second degree burns and third degree burns require early burn wound excision (3-5 days) and skin grafting for optimal wound healing.

Fourth degree burns:

These injuries extend to other organs beneath the skin, like the fat, muscle, tendon, bone or brain. Treatment requires elaborate debridement and skin cover either by a graft or flap.



Diagnostic ambiguity [4]:

Very shallow and very deep burn wounds (charred full thickness burns) pose little diagnostic difficulty even to inexperienced burn care physician. However, blistering may not occur for few hours following injury. And initially assumed to be epidermal burns can subsequently turn to be superficial partial burns on day 2.

Some full thickness burns, especially immersion scalds may be erythematous and confused with superficial partial thickness or epidermal burns. Though red, these wounds do not blanch to pressure.

Unfortunately there are many burn wounds whose depth cannot be assessed properly as they do not fit exactly to the defined classifications and are termed the indeterminate burns. Indeterminate burns are best managed by operative means rather than by wound dressing.

Understanding the importance of burn depth estimation, intense research has been done in this field. A number of techniques have evolved but none of the method is recommended at present, for clinical practice.

1. The ability to detect dead cells or denatured collagen (biopsy, vital dyes).
2. Altered blood flow (laser Doppler flow meter, thermography).
3. The color of the wound (light reflectance method).

4. Physical changes such as edema (magnetic resonance imaging).

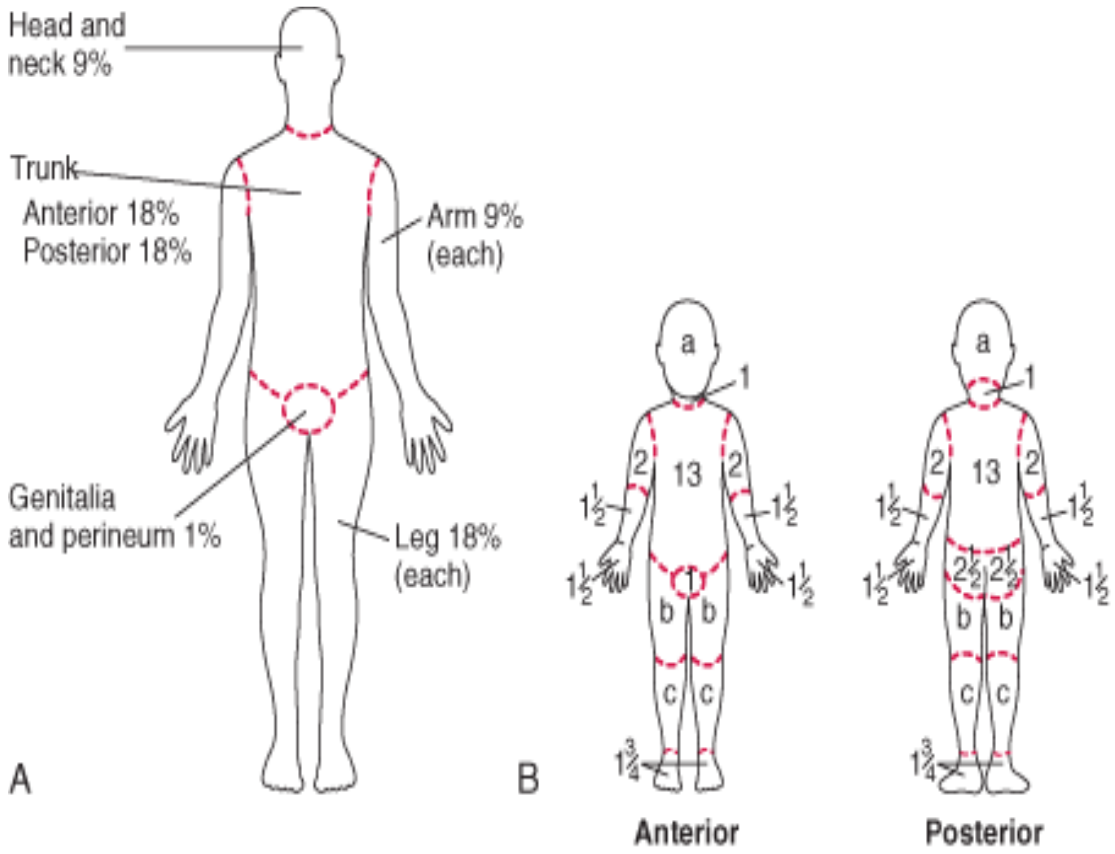
ESTIMATION OF BURN SIZE [1]:

Estimating the burn size helps in assessing the extent of injury. There are several formulas for estimating burn size, of which the “Wallace rule of nine”, is the most commonly used. In adults, 9% is given to each upper extremity, head and neck; 18% is given to each lower extremity, anterior and posterior trunk and 1% to the perineum. In children, 18% is given for head and neck, and 14% for each lower extremity. In infants,21% is given for head and neck, and 13% for each lower extremity.

The Berkow formula is used to determine burn size accurately in children.

Lund and Browder chart can also be used to estimate burn size as it has age appropriate calculations for determining the burnt area with respect to the TBSA. It is a pictorial representation.

WALLACE RULE OF NINE AND BROWDER AND LUND CHART:



Relative percentage of body surface area (% BSA) affected by growth

	Age				
Body Part	0 yr	1 yr	5 yr	10 yr	15 yr
a = 1/2 of head	9 1/2	8 1/2	6 1/2	5 1/2	4 1/2
b = 1/2 of 1 thigh	2 3/4	3 1/4	4	4 1/4	4 1/2
c = 1/2 of 1 lower leg	2 1/2	2 1/2	2 3/4	3	3 1/4

How does burn wound differ from other wounds?

1). The capillary permeability due to heat effect is long-lasting, which is maximum in the first eight hours and the plasma leak persists till 48 hours.

2). Most of the burn wounds are sterile at the time of injury. Heat effect kills the organisms on the surface. It is only after the first week of burns,

the wounds get infected leading to sepsis. The source of infection is usually external or from the skin appendages (hair follicles and sebaceous glands) that survives the burn. Systemic antibiotics have limited role in burns, except in burn wound sepsis.

3). Burn wound is associated with suppressed immunity. For example, unlike a degloving injury burn injury of similar extent, burn wound is associated with immune suppression.

4). An Extensive burn is a severe catabolic injury that extends years beyond post injury unlike other wounds where the catabolic phase is short-lived.

MANAGEMENT OF BURN PATIENTS [1]:

PREHOSPITAL CARE:

The victim should be removed from the source of burn. If the patient is still on fire, he should be asked to roll down on the ground. The rescuer should safe guard himself first; otherwise he will become another victim. Burning clothes or burnt clothes has to be removed at the earliest. Water available nearby should be poured over the victim. Exposure to water should not be more than fifteen minutes otherwise it will lead to dangerous hypothermia. In addition it can increase the depth of injury. Ice should not be applied as it cause vasoconstriction and deepen the burn wound. Belt, watch, ring, chain, bracelets all has to be removed, else it will cause contact burns and will pose difficulty removing them once burn edema sets in. The victim has to covered with clean cloth and transported.

Airway injury has to be suspected and 100% O_2 given by mask prophylactically. As with any trauma patient, assessment is done by primary and secondary surveys.

In primary survey, life threatening conditions are looked for quickly. In secondary survey, a thorough clinical examination is made.

HOSPITAL CARE:

Airway injury is suspected in those with breathlessness, facial burns, blackish sputum and singed airway. Those with hoarseness of voice, early intubation is done, otherwise the burn edema that ensues resuscitation, will compromise airway severely and make intubation difficult.

Intravenous access is obtained. Short doses of intravenous narcotics can be given (morphine). Empirical antibiotics are given. Intramuscular opioid should never be given because due to peripheral vasoconstriction, drug absorption is impaired and upon resuscitation, these drugs enter the circulation and can cause apnea.

. Inj. Tetanus Toxoid 0.5 cc i.m given and 250IU tetanus immunoglobulin is given, if previous immunization history is unclear or booster given > 10 years. Intravenous fluids are started .Ringer lactate is the fluid of choice. For children less than 20kg, Ringer lactate with 5% Dextrose is the ideal fluid as they have no adequate glycogen store.

The most commonly used formula is the **Parkland's formula**:

Volume transfused in ml = 4* weight in kg * % TBSA burn.50% of the total fluid is to be transfused in the first 8 hours. Next 50% is to be transfused in the next 16 hours.

Other formula that uses Ringer lactate and colloid **is Brooke's formula**.

Volume transfused = 1.5ml/kg/%TBSA burn (RL) + 0.5ml/kg/% TBSA burn (colloid) + 2 liters of free water. Colloid is administered only after 24 hours. After 24 hours, plasma volume returns to normal due to colloid administration.

For pediatric population, **Galveston formula** is used.

Volume transfused = 5000ml/m^2 burned area + 1500 ml/ m^2 total area.

All these formulas guide only in initial fluid management. Further need for fluid is guided mainly by clinical parameters like mean arterial pressure and urine output. The mean arterial pressure has to be above 60mm Hg and urine output between 0.5 – 1 ml/kg/hr.

Hypovolemia in burns is due to isotonic fluid loss from the blood vessels into the interstitium. Extensive research in experimental models has shown that the type of fluid in the first 24 hours has no effect on plasma volume changes due to high capillary permeability. However after 24 hours, colloid infusion increases plasma volume

When hypertonic saline is used as resuscitation fluid, it reduces edema and fluid requirement. But must be careful that serum Na^+, does not

exceed 160meq/l. It also carries the risk of causing hyperchloremic metabolic acidosis and renal failure. Beyond 20% TBSA, there is no significant difference in fluid requirement between those using RL and hypertonic saline.

The phenomenon of fluid creep [4]:

Studies have proved that Parkland's formula usually underestimates the fluid need and the trend towards providing fluid in excess has resulted in "fluid creep".

The problems of over resuscitation:

1. Elevated orbital pressure
2. Pulmonary edema
3. Prolonged mechanical ventilation
4. Graft failure
5. Need for fasciotomy of uninjured limbs
6. Abdominal compartment syndrome in the absence of abdominal injury

The type of fluid, timing and total volume infused all influence the fluid shifts.

LOCAL WOUND CARE:

As resuscitation is underway, burn wound is assessed for the second time for its size and depth. Wound is cleaned and debrided, if needed. Then the wounds are subjected to application of topical antibiotic alone, topical antibiotic with dressing or dressing alone.

Burn wound eschar:

Usually occurs in deep II degree and full thickness burns. They are unyielding and can compromise vascularity which is evidenced by numbness, tingling sensation, increased pain and decreased capillary refill.

If the eschar involves the thorax it can compromise respiration.In the abdomen it causes, abdominal compartment syndrome.

Treatment is by escharotomy under appropriate anesthesia.

If vascular compromise is longstanding, on release of the eschar, reperfusion injury can occur, leading to hypotension and death. Adequate blood has to be reserved. By using diathermy, blood loss can be reduced during escharotomy.

SILVER SULPHADIAZINE:

Dressing of burn wound by antimicrobial agent helps in destroying organisms present in the skin appendages. It also prevents contamination of the wound by microorganisms from the environment. The proliferation of microorganisms starts from the deep surface of the eschar after day 5. The eschar being a non- viable tissue behaves as a good culture media for the microbial proliferation. This subeschar microbial proliferation may later invade the deeper tissues and are the reason for burn wound sepsis. Mupirocin and neomycin cannot penetrate eschar and are ineffective in control of subeschar bacterial invasion. Therefore for burn wounds the ideal topical antibiotic is the one that penetrates the eschar. If the burn surface area is large, there is every possibility that the antibiotic applied can penetrate into the circulation. Hence the agent used should have minimal toxicity on systemic absorption.

Silver sulphadiazine is a broad spectrum antimicrobial active against gram positive, most gram negative and some fungal organisms. Its an antimetabolite acting by competitively inhibiting folate synthase enzyme. Human cells use dietary folic acid and hence, the enzyme inhibition is selectively toxic to the microbes.

It is painless but sometimes causes burning sensation. It is easy to use and do not penetrate eschars. The silver ion, may leave black tattoos

on skin. There is mild inhibition of epithelialisation. Leucopenia may develop in 3 to 5 days of its use, which is self limiting.

COLLAGEN SHEET [34]:

India being a tropical country, closed dressings get easily infected whereas open dressings get dried up soon. Collagen sheets in India are of bovine origin andare synthesized by the Central Leather Research Institute, in Chennai. They are reconstituted after extracting from the bovine skin and Achilles tendon.

Collagens are the most abundant and ubiquitous proteins in vertebrates. It provides mechanical support to the connective tissue, substrate for cell adhesion and migration. It is less antigenic and haemostatic. It has no threat of HIV, Hepatitis. Bovine material is obtained from countries free of Bovine spongiform encephalopathy.

Collagen dressings create the most physiological interface between the wound surface and the environment. They are impermeable to bacteria, which enables the body's immune and reparative mechanism to act effectively. It is easy to apply and has a long shelf life. It eliminates painful daily dressing and decreases fluid loss.

ADVANTAGES OF COLLAGEN APPLICATION:

1. Ease of application

2. Dressing need to be applied only once
3. Ease of removal
4. Availability in various sizes
5. Remains stable at room temperature upto 3 years
6. Can adapt to hot humid climates as in India
7. Cost effective when compared to other biological dressings
8. There is no significant immunological response to collagen sheet application
9. It is soft, supple, has good tear strength, good suturing characteristics, elastic and enough strength to be peeled off intact from the wound.
10. It is patients of this group who enjoyed early mobility
11. They also had significantly lower pain score and wound healing time
12. Occurrence of any wound infection can be easily inspected through the sheet, owing to its transparency.

DISADVANTAGES OF COLLAGEN SHEET APPLICATION:

1. On applying these membranes over the flexor aspect, they tend to crack as they dry up.
2. Because of the transparent nature, the wound is visible to the patient and can cause considerable apprehension.

AIM OF THE STUDY:

To compare the efficacy of collagen sheet versus conventional SSD ointment in II degree fresh thermal burns with respect to

1. Intensity of pain
2. Occurrence of wound infection
3. Rate of wound healing
4. Need for split skin grafting
5. Development of contractures and hypertrophic scars.

MATERIALS AND METHODS:

Study population:

Patient getting admitted with II degree burns less than 20% in the general surgery and pediatric surgery departments of CMCH , Coimbatore.

Study period:

October 2011 – October 2013

Study design:

Prospective controlled study

Inclusion criteria:

1. All patients from 8 years to 60 years
2. 0-20% II degree burns
3. < 12 hours time interval between the incident and hospital admission
4. Uncontaminated burn wounds

Exclusion criteria:

1. Those patients <8 years , >60 years
2. >20% burn surface area

3. Full thickness burns
4. Those patients getting admitted beyond 12 hours after the incident
5. Grossly contaminated burn wounds
6. Electrical, chemical and radiation burns
7. Uncontrolled diabetes
8. Steroid users
9. Cancer patients
10. Other immunocompromised patients
11. Protein energy malnourished child
12. Moderate & severely obese individuals(BMI > 35)
13. Patients with severe cardio-respiratory compromise , renal failure , decompensated liver disease etc
14. Burns occurring in a paralytic limb

Methodology:

Thorough history taking regarding the mode of injury, duration of exposure, possibility of inhalation injury , time of incident , associated co morbidities were taken from the patients. Surface area of burns assessed by Wallace rule of nine.. 70 patients were enrolled for the study.

Informed written consent from the patients , relatives , parents or guardians were obtained. The 70 patients were randomly divided into test and control populations, 35 in each group. For every patient in the control group , another patient with similar age , sex , TBSA , site of burn was assigned to the test group as far as possible.

Preparation of the patient:

All patients were managed with analgesics, intravenous fluids according to Parkland's formula – Ringer lactate for adults and Ringer lactate with dextrose saline for pediatric patients. All patients were given first dose of empirical antibiotics

Inj cefotaxime 100mg/kg/day

Inj amikacin 15mg/kg/day

Inj metronidazole 15mg/kg/day(the protocol followed in CMCH)

Injection Tetanus toxoid 0.5cc given i.m. Wound washed thoroughly with normal saline. The wound was then dried. Each patient was randomly assigned to the control or test group & SSD application or collagen sheet application was done respectively.

For the purpose of study, the patients were admitted till near complete epithelialisation.

Application of collagen sheet:

- Thorough wash of the collagen sheets with normal saline done three to four times and then applied over the wound.
- Any air that gets trapped was removed with the back of the forceps.
- Burn areas where the dressings were in contact with beddings , Vaseline gauze, G pads and roller bandage were applied for 48 hours.

Whenever the collagen sheet dressing crossed the joint, appropriate splinting was done.

Intolerable pain , soakage were considered the criteria for opening the dressing early. For other patients collagen sheets were applied and left

open. The transparency of the sheet helped in supervising for the presence of any wound infection.

Application of Silver sulphadiazine ointment:

1% silver sulphadiazine ointment was applied over the wound using sterile gauze on a sponge holder. After application the wound was left open.

The following observations were made:

Pain on day1& day2(using the scoring system mentioned below), presence of wound infection, type of organism grown, duration of wound healing, need for split skin graft, extent of ambulation, development of contractures and hypertrophic scars.

Pain was quantified approximately by the following scoring system every morning and evening and the average taken. The assessment of pain was done on the first two consecutive days.

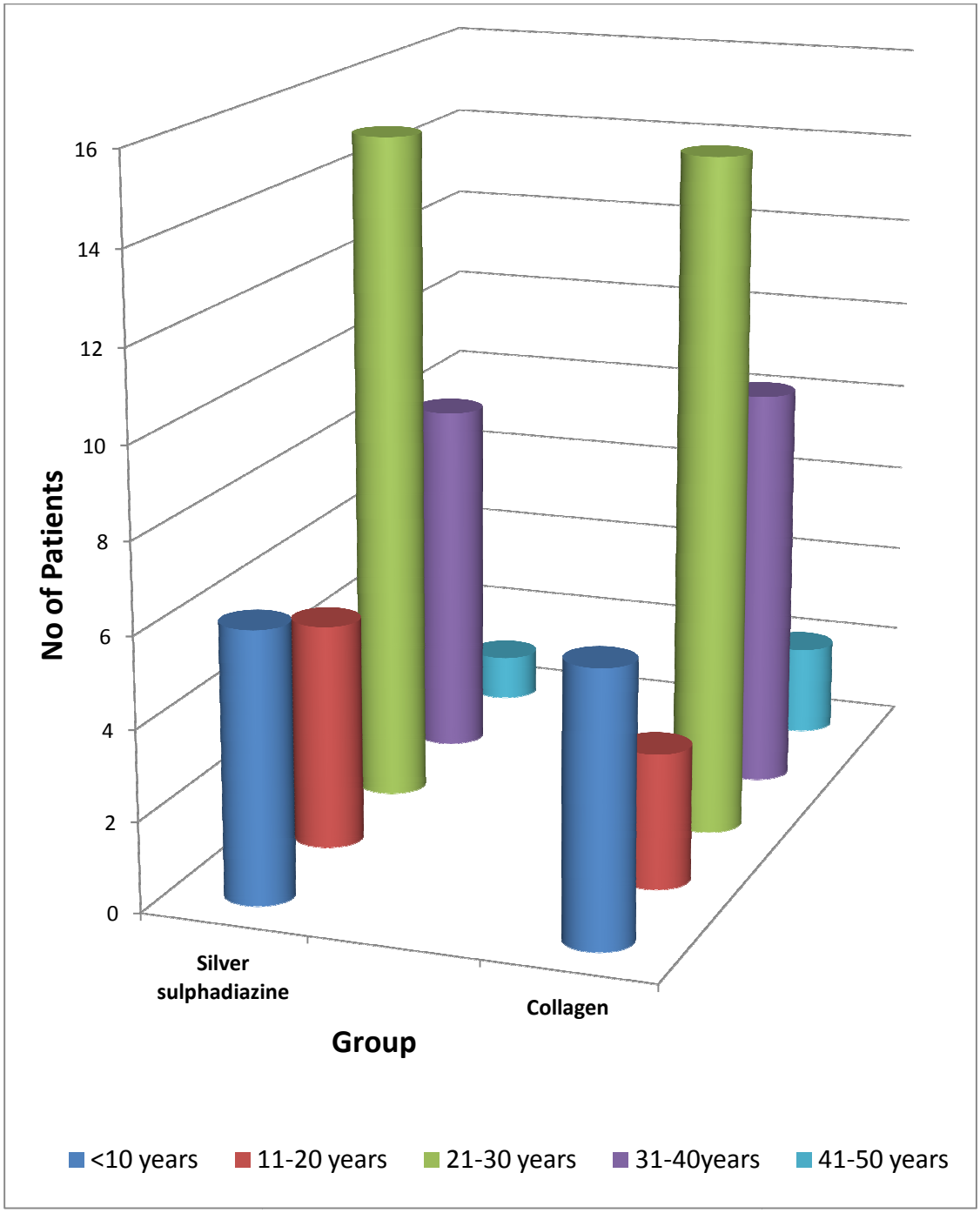
Pain	Score
Tolerable	1
Difficult to tolerate	2
Impossible to tolerate	3

Infection of wound noted clinically by redness and pus discharge, warranted removal of collagen. Antibiotics were given according to culture sensitivity reports.

OBSERVATION AND RESULTS:

I. Age distribution:

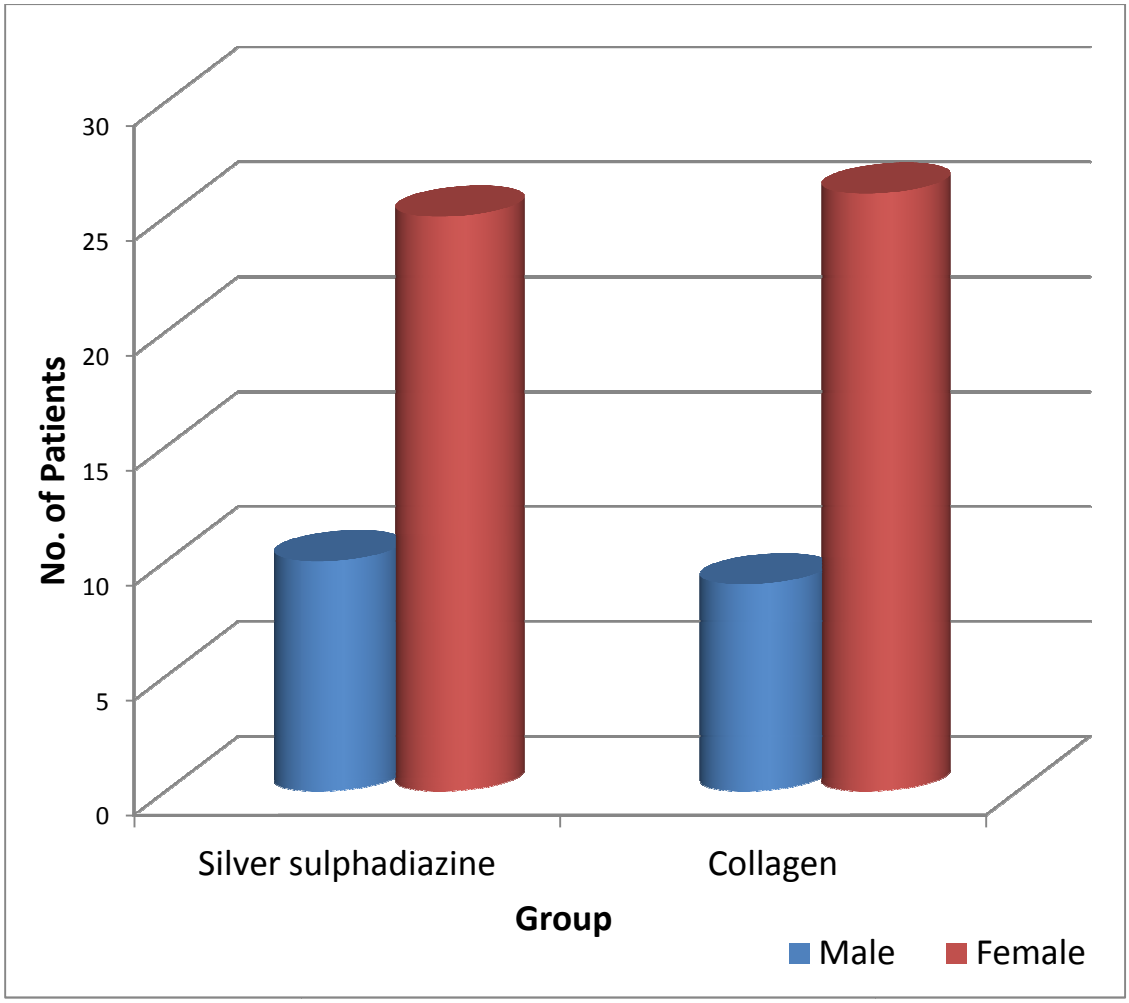
Age group (years)	Silver-sulphadiazine group		Collagen group	
	No. of patients	Percentage	No. of patients	Percentage
<10	6	17.14	6	17.14
10-20	5	14.30	3	8.60
20-30	15	42.85	15	42.85
30-40	8	22.85	9	25.71
40-50	1	2.80	2	5.70
Total	35	100	35	100



In our study, the incidence of burns was more common in 20 – 30 years followed by 30 – 40 years, the most productive age group.

II. Sex distribution:

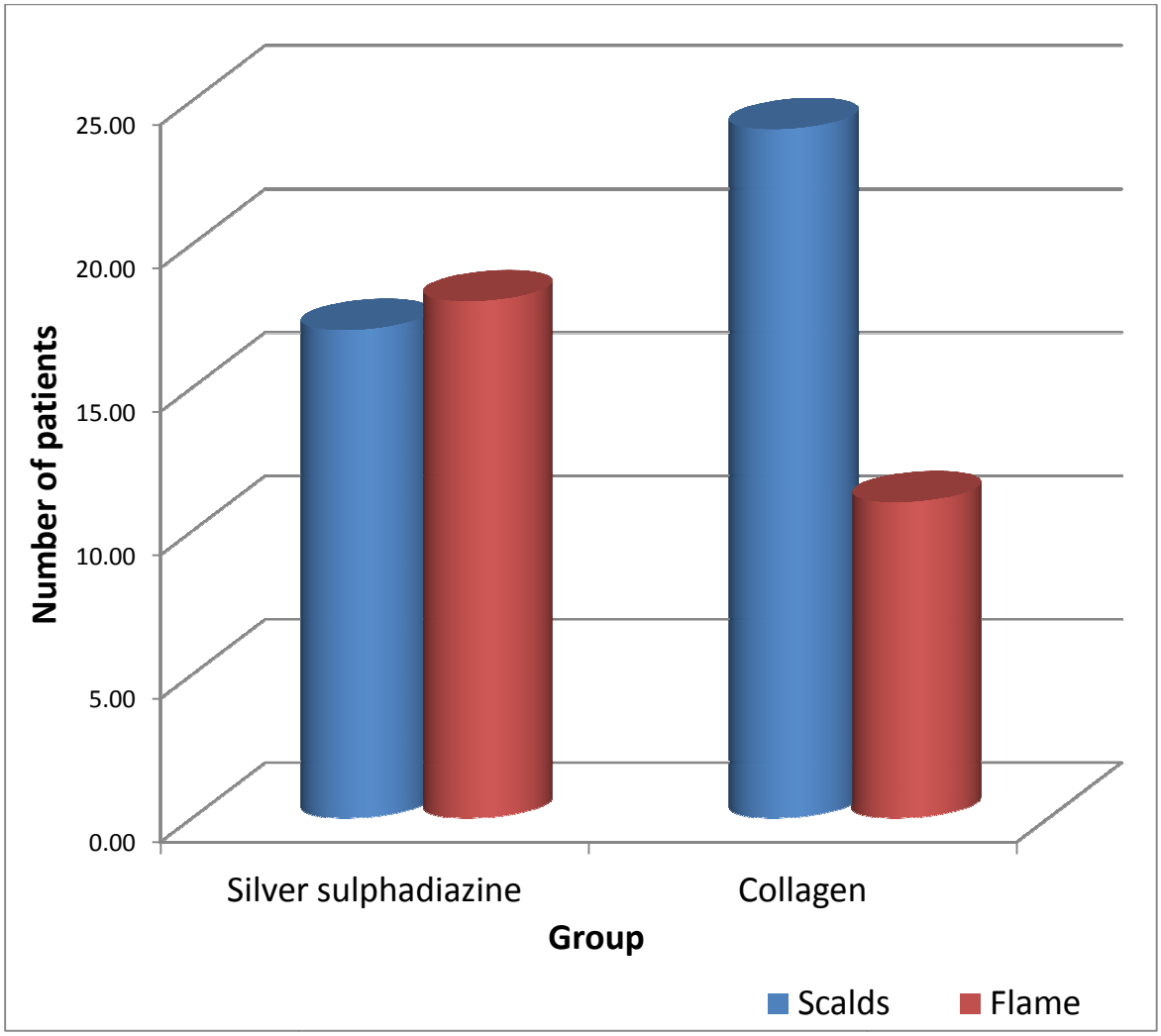
Sex	Silver-sulphadiazine group		Collagen group	
	No. of patients	Percentage	No. of patients	Percentage
Male	10	28.6	9	25.7
Female	25	71.4	26	74.3
Total	35	100	35	100



In our study, burns were predominant among females (74.3%).

III. Mechanism of injury:

Mode of injury	Silver-sulphadiazine group		Collagen group	
	No. of patients	Percentage	No. of patients	Percentage
Scalds	17	48.6	24	68.6
Flame	18	51.4	11	31.4
Total	35	100	35	100



Scalds account for 48.6% of burns in the silver sulphadiazine group and 68.6% in the collagen group.

IV. Pain score

Average Pain Score	Silver-sulphadiazine group				Collagen group			
	No. of patients		Percentage		No. of patients		Percentage	
	Day1	Day2	Day1	Day2	Day1	Day2	Day1	Day2
1	0	4	0	11.43	29	32	82.86	91.43
1.5	0	0	0	0	4	3	11.43	8.57
2	24	26	68.57	74.29	2	0	5.71	0
2.5	9	5	25.71	14.28	0	0	0	0
3	2	0	5.71	0	0	0	0	0
Total	35	35	100	100	35	35	100	100

<u>Statistical analysis of pain on day1:</u>

Group	Day 1		
	Mean	Standard Deviation	No. of patients
SSD	2.19	0.30	35
Collagen	1.11	0.27	35

T-test for Equality of Means

t	Df	Prob	Sig.
15.639	68	.001	P<0.01

P<0.01 – Significant at 1% level.

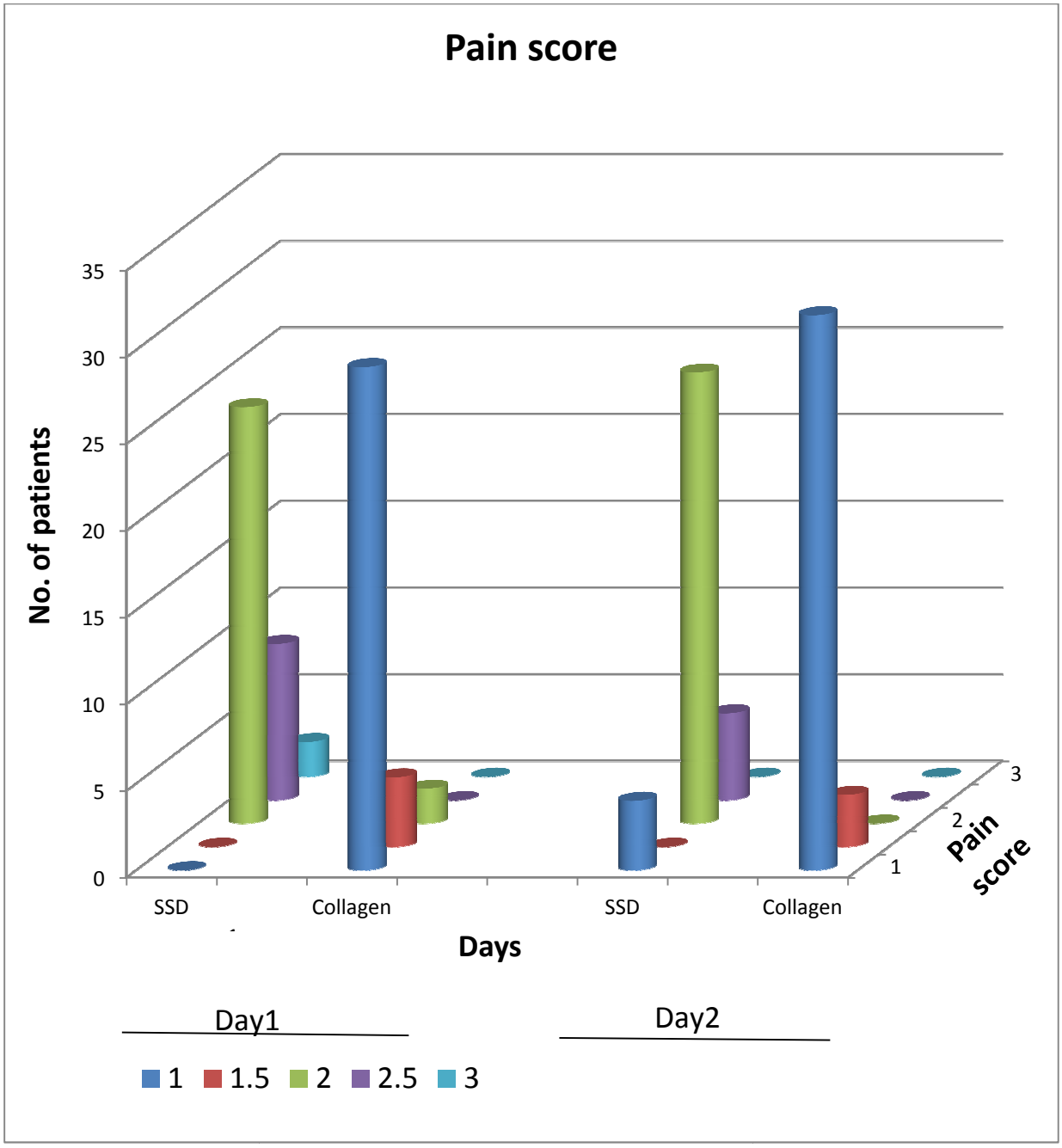
Statistical analysis of pain on day2

Group	Day 2		
	Mean	Standard Deviation	No. of patients
SSD	1.96	0.39	35
Collagen	1.04	0.14	35

T-test for Equality of Means (on day2)

t	df	Prob	Sig.
13.016	68	.001	P<0.01

P<0.01 – Significant at 1% level



On days1and 2, the pain in collagen group was significantly lesser than that in silver sulphadiazine group. (Significant at 1% level)

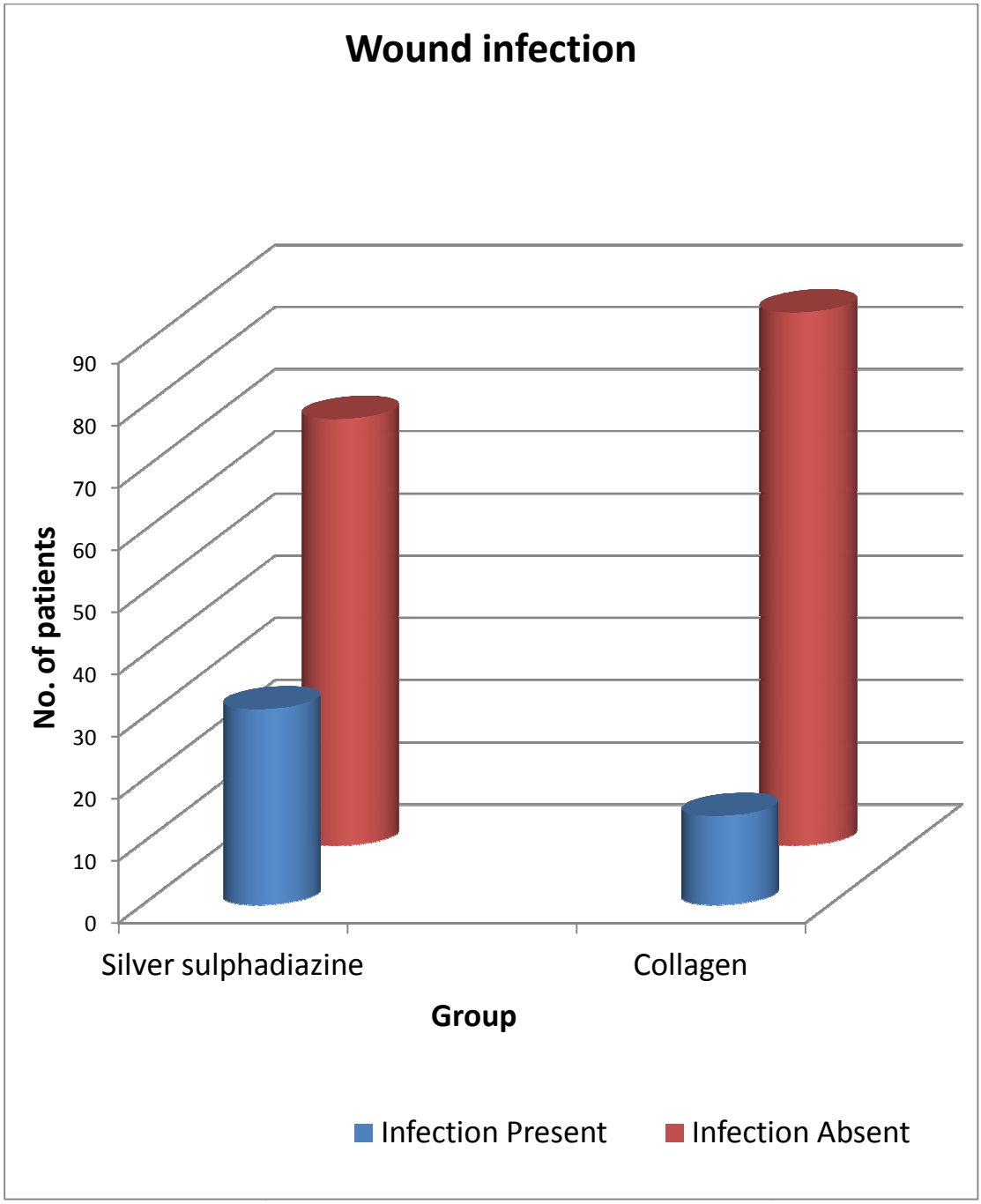
V. Wound Infection:

Group	**Silver-sulphadiazine group**		**Collagen group**	
	No. of patients	Percentage	No. of patients	Percentage
Infection Present	11	31.43	5	14.28
Infection Absent	24	68.57	30	85.72
Total	35	100	35	100

Statistical analysis of wound infection:

		Infection				TOTAL	
		Absent		Present		No.	%
		No.	%	No.	%		
Group	SSD	24	68.6	11	31.4	35	100.0
	Collagen	30	85.7	5	14.3	35	100.0
TOTAL		54	77.1	16	22.9	70	100.0

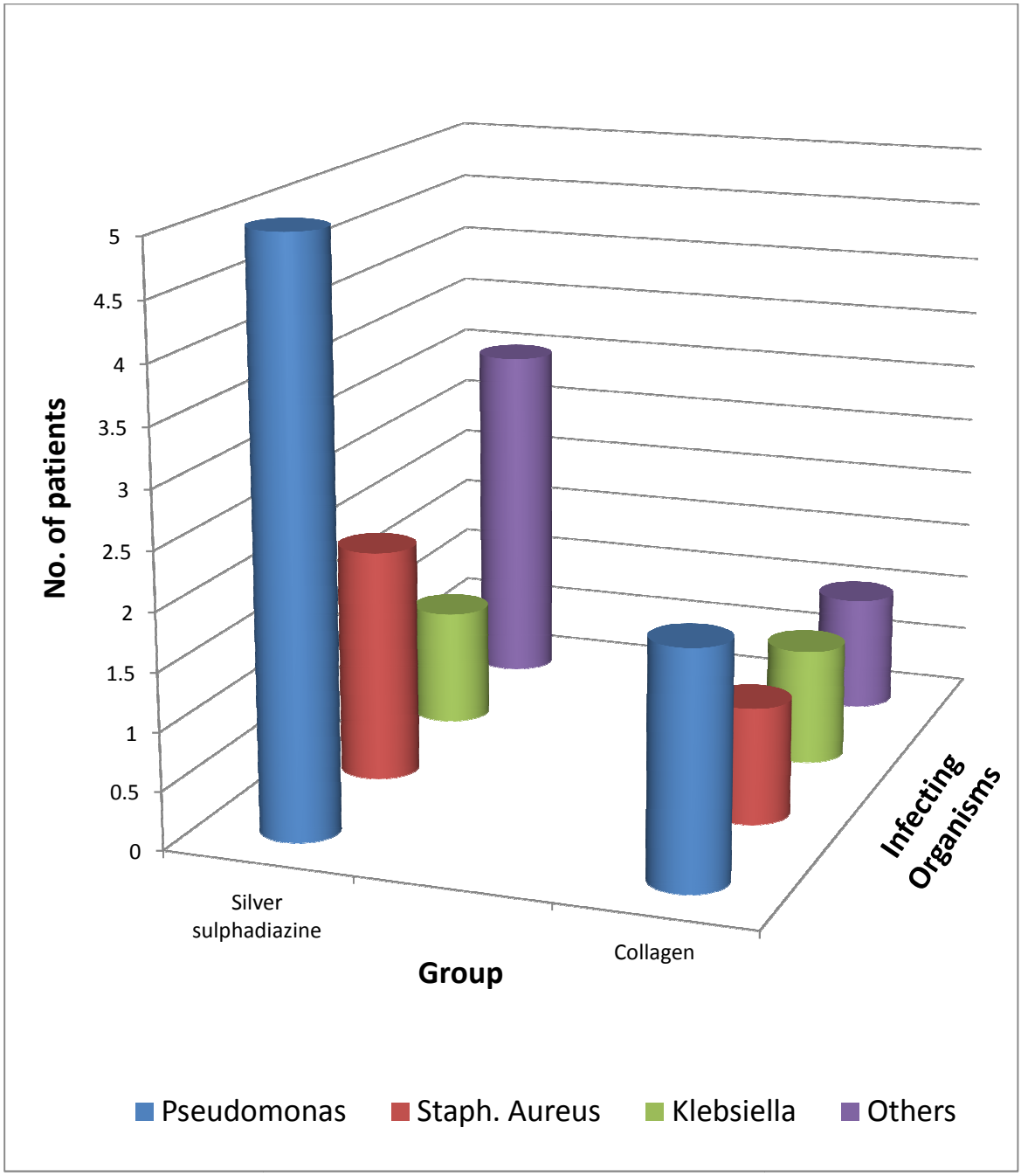
Test of proportions (P-test) Critical Ratio=1.708. Ns(P>0.05)



Though the number of wound infection was more in the silver sulphadiazine group it is not statistically significant.

VI. Distribution of infecting organisms:

Organisms cultured	**Silver-sulphadiazine group**		**Collagen group**	
	No. of patients	Percentage	No. of patients	Percentage
Pseudomonas	5	45.45	2	40
Staph. Aureus	2	18.18	1	20
Klebsiella	1	9.09	1	20
Others	3	27.27	1	20
Total	11	100	5	100



The most common organism infecting the burn wound was pseudomonas species followed by staphylococcal aureus.

VII. Need for SSG:

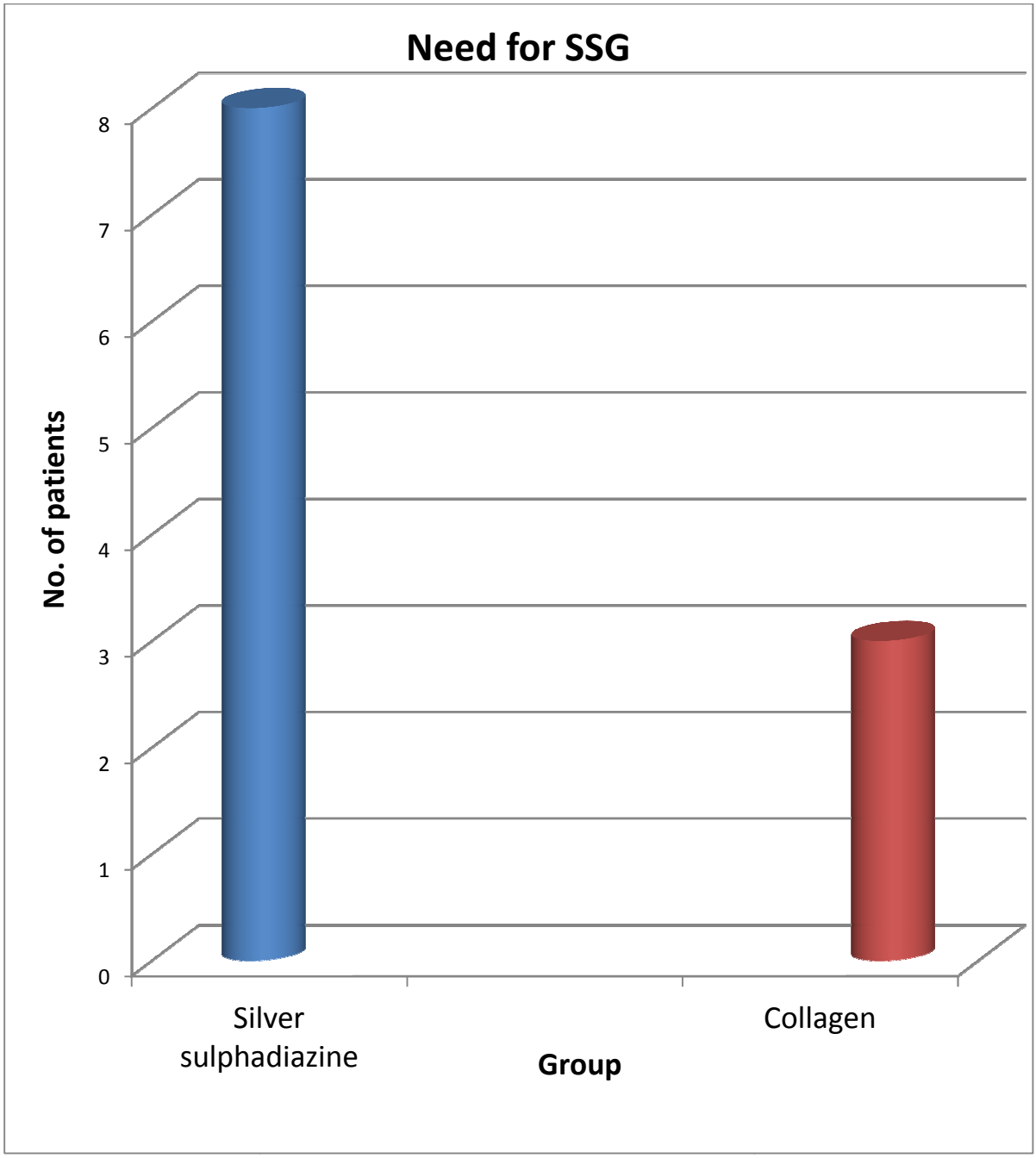
Silver-sulphadiazine group		**Collagen group**	
No. of patients	Percentage	No. of patients	Percentage
8	22.85	3	8.57

Statistical analysis of the need for SSG

		Need for SSG				TOTAL	
		No		Yes		No.	%
		No.	%	No.	%		
Group	SSD	27	77.1	8	22.9	35	100.0
	Collagen	32	91.4	3	8.6	35	100.0
TOTAL		59	84.3	11	15.7	70	100.0

Test of proportions (P-test) Critical Ratio=1.642. Ns(P>0.05)

.



Though more number of patients required split skin graft in the silversulphadiazine group, it is not statistically significant.

VIII. Duration of healing:

	Silver-sulphadiazine group	**Collagen group**
Average duration	17.48 Days	13.6 Days

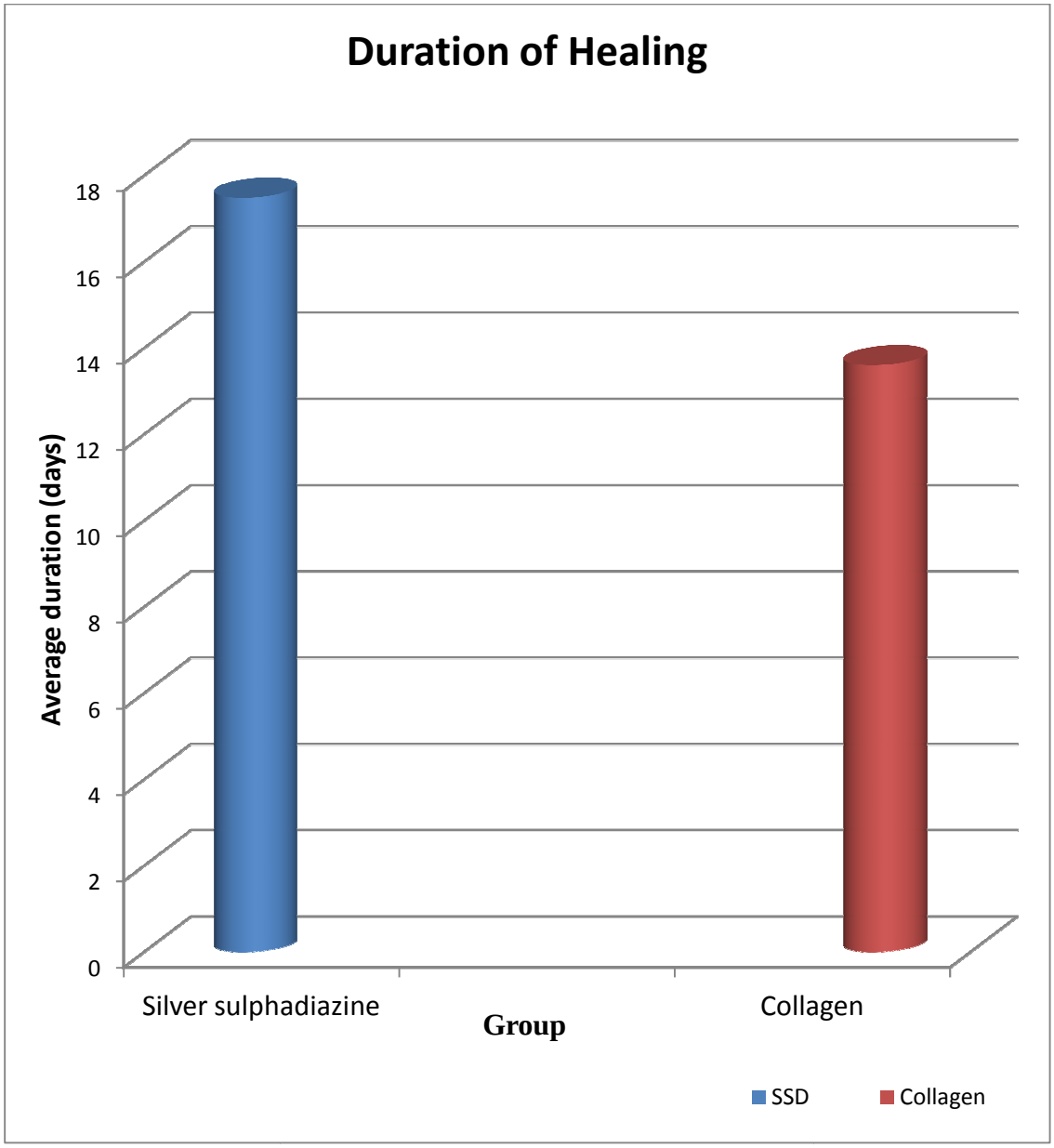
Statistical analysis of the duration of healing:

		Time for Healing(days)		
		Mean	S.D	No.
Group	SSD	17.49	3.08	35
	Collagen	13.60	2.68	35

T-test for Equality of Means:

t	df	Prob	Sig.
5.629	68	.001	P<0.01

P<0.01 – Significant at 1% level.



The wound healing in the collagen group was significantly shorter than the silver sulphadiazine group (13.6 days vs 17.49 days).

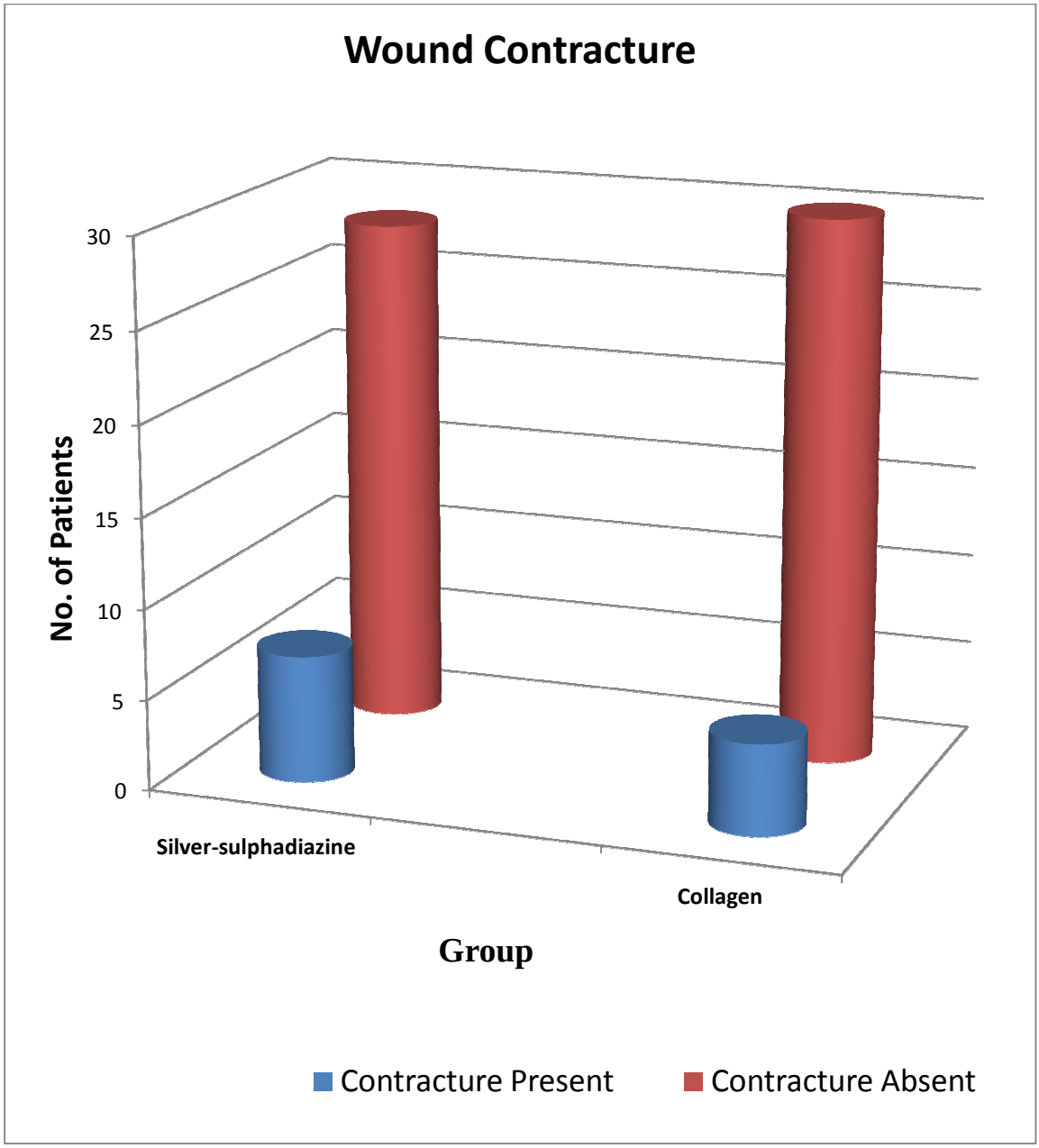
IX. Wound Contracture:

Wound Contracture	**Silver-sulphadiazine group**		**Collagen group**	
	No. of patients	Percentage	No. of patients	Percentage
Present	7	20	5	14.29
Absent	28	80	30	85.71
Total	35	100	35	100

Statistical analysis of the wound contracture:

		Contracture				TOTAL	
		No		Yes		No.	%
		No.	%	No.	%		
Group	SSD	28	80.0	7	20.0	35	100.0
	Collagen	30	85.7	5	14.3	35	100.0
TOTAL		58	82.9	12	17.1	70	100.0

Test of proportions (P-test) Critical Ratio=0.634. Ns(P>0.05)



The incidence of contracture was more in the silver sulphadiazine group but it is not statistically significant.

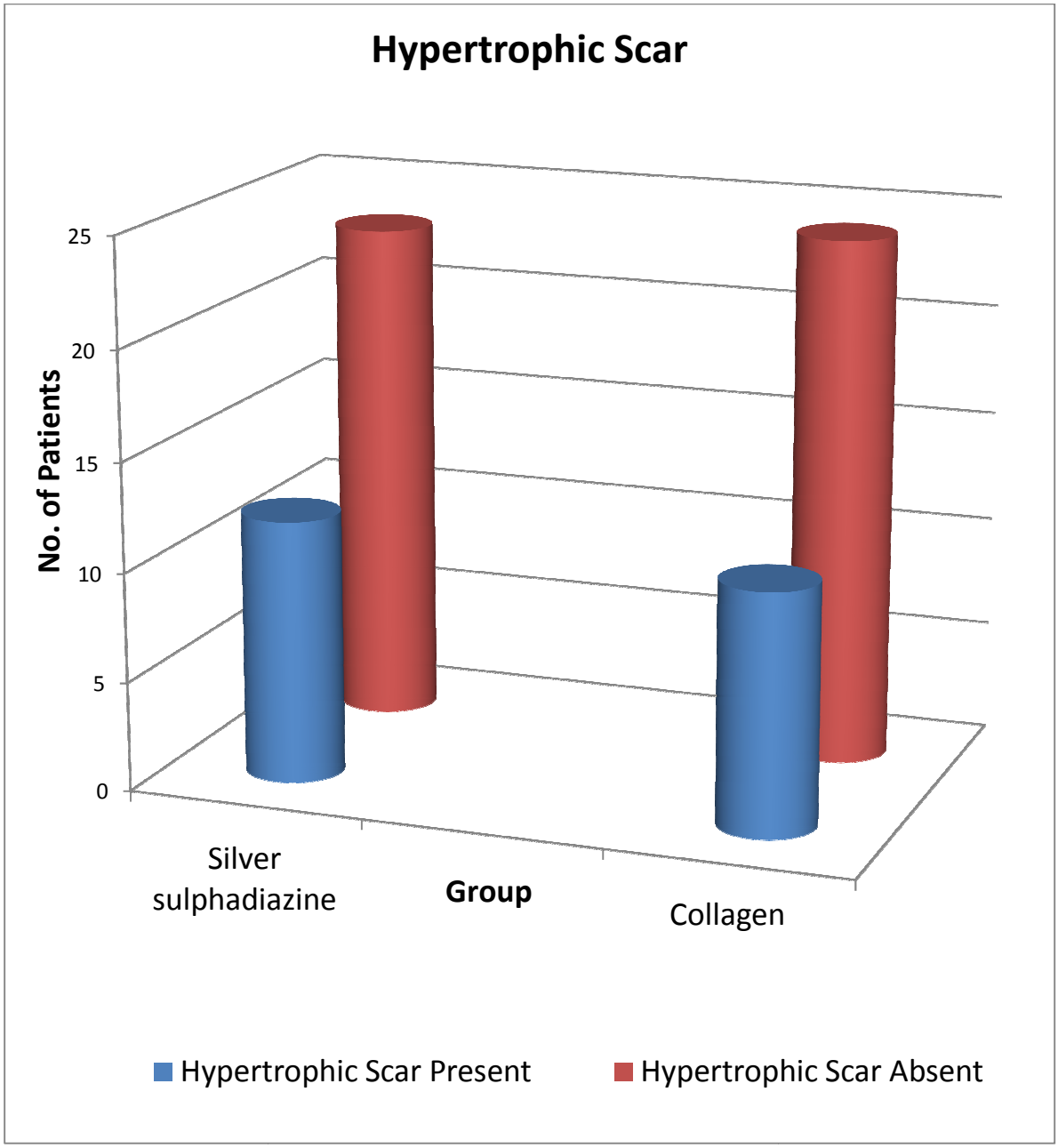
X. Hypertrophic Scar:

Hypertrophic Scar	**Silver-sulphadiazine group**		**Collagen group**	
	No. of patients	Percentage	No. of patients	Percentage
Present	12	34.29	11	31.43
Absent	23	65.71	24	68.57
Total	35	100	35	100

Statistical analysis of hypertrophic scar:

		Hypertrophic scar				TOTAL	
		Nil		Positive		No.	%
		No.	%	No.	%		
Group	SSD	23	65.7	12	34.3	35	100.0
	Collagen	24	68.6	11	31.4	35	100.0
TOTAL		47	67.1	23	32.9	70	100.0

Test of proportions (P-test) Critical Ratio=0.254. Ns(P>0.05)



Though the incidence of hypertrophic scar was more in the silver sulphadiazine group, it is not statistically significant.

SUMMARY OF OBSERVATION AND RESULTS:

In the silver sulphadiazine group, the average pain score (over a scale of 3) on day one was, 2.19 whereas the collagen group had an average pain score of only 1.11.

Similarly on day two, the average pain score in the silver sulphadiazine was 1.96, whereas in the collagen group it was only 1.04.

On both the days, it was found to be statistically significant that the collagen group experienced lesser pain than the silver sulphadiazine group.

In the silver sulphadiazine group, the average duration of wound healing was 17.48 days versus 13.6 days in the collagen group. The shorter healing time in the collagen group was found to be statistically significant.

11 patients (31.4%) developed wound infection in the silver sulphadiazine group and 5 patients (14.3%) in the collagen group. Though wound infection was slightly less in the collagen group, it was not statistically significant.

8 patients (22.85%) in the silver sulphadiazine group and 3 patients (8.57%) in the collagen group required split thickness graft. The difference in the two groups was found to be statistically insignificant.

7 patients (20%) in the silver sulphadiazine group and 5 patients (14.3%) in the collagen group developed contractures. The difference in the two groups was statistically insignificant.

12 patients (34.3%) in the silver sulphadiazine group and 11 patients (31.4%) in the collagen group developed hypertrophic scars. The difference in the two groups was statistically insignificant.

DISCUSSION:

PAIN SCORE:

- In this study, the pain score on day 1 was 1.1 versus 2.2 between the collagen and the silver sulphadiazine group. And on day 2, the score was 1.04 versus 1.9 between the collagen and silver sulphadiazine groups.
- In the study conducted by Gupta et al in 1978, they observed that patients in the collagen group experienced significant pain relief.
- In the study by Gerdling et al in 1988, they noted an average pain scale of 1.6 in the collagen group and 3.6 in the SSD group.
- Barret et al in 1999, observed a significant difference in the pain score between the collagen and silver sulphdiazine groups (2.4 v/s 3.7).

HEALING TIME:

- The current study observed a healing time of 13.6 days in the collagen group versus 17.48 days in the silver sulphadiazine group.
- The study of Gupta et al, conducted in 1978, has shown that the duration of healing in the collagen group was between 10 and 14 days.

- The study of Gerdling et al in 1988, conducted in those with less than 10% burns showed a healing time of 10.6 days in the collagen group versus 15 days in the silver sulphadiazine group.
- The study of Barret et al in 1999, observed a healing time of 9.5 days in the collagen group versus 16.1 days in the silver sulphadiazine group.

WOUND INFECTION:

- Incidence of wound infection was found to be low with collagen application in various studies. In this study the incidence of wound infection in the collagen group was slightly lower than the silver sulphadiazine group (5 versus 11 patients). The difference in two groups however was statistically insignificant.
- Frank et al in 1983 proved that collagen dressings firmly adhere to the wound and decrease the rate of bacterial contamination.
- Yang et al in 1990, studied with young collagen wettable membrane as burn wound dressing. He observed that owing to its semi-transparency, submembrane suppuration was detected early.

CONCLUSION:

In this study, we conclude that collagen application is better than silver sulphadiazine application in the management of burn wounds for the following reasons:

1. Pain score was significantly lower in the collagen group, when compared with the silver sulphadiazine group.
2. Healing was significantly faster in the collagen group.
3. Patients in the collagen group required dressing only once.
4. Patients in the collagen group were ambulant early and hence reduced the burden of the attending staff and patient's relatives.
5. Occurrence of wound infection was identified early in the collagen group owing to its translucency so that appropriate antibiotics were instituted early.

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ANNEXURES

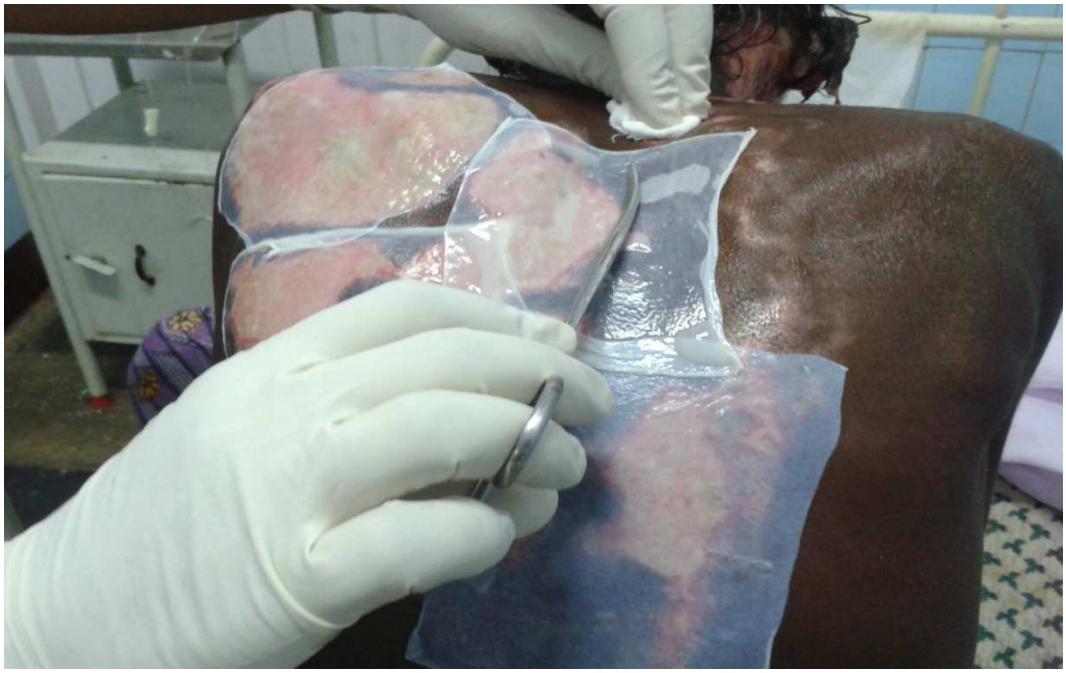
I. Second degree burns:

II. Application of silver sulphadiazine ointment:

III. Silver sulphadiazine ointment:

IV. Collagen sheet:

V. Application of collagen sheet:



VI. Peeling of the collagen sheet:

PROFORMA:

- **Patient characteristics:**
  - Name:
  - Age :
  - Sex :
  - Inpatient number:
  - Address :

  - Date and time of admission:
  - Date of discharge:
  - Place of incident:
  - Time of incident:
  - Mode of injury:
    - Hot liquid/ kerosene stove explosion / pouring of kerosene over himself and igniting /while pumping the stove/ burns while rescuing a person on fire etc
  - Type of burn: Flame/ Scald/ Contact burn
  - Duration of exposure to the source:
  - First aid given : Yes/ No.
    - If yes, with what?
  - Evidence of inhalation injury: Yes/ No.

- Mode of treatment:
    - Traditional silver sulphadiazine application
    - Collagen sheet application

- **Past history:**
    - Diabetes/ hypertension /tuberculosis / asthma / heart disease / epilepsy/ psychiatric disorder / chronic medication / drug allergy / surgery
- **Menstrual history:**
- **Marital history:**
- **Obstetric history:**
- **Personal history:**
    - Alcoholic/ smoker
- **General examination:**
    - Consciousness
    - Orientation
    - Built
    - Nourishment
    - Anemia
    - Jaundice
    - Clubbing
    - Cyanosis

- Generalized lymphadenopathy
- Bilateral pedal edema

- **Examination of vitals:**
  - Pulse rate
  - Respiratory rate
  - Blood pressure
  - Capillary refill time
- **Systemic examination:**
  - Cardiovascular system
  - Respiratory system
  - Abdomen
  - Central nervous system
- Estimation of surface area of burns by **"Wallace rule of nine"**
- **Investigations :**
  - Blood sugar, urea
  - Complete blood count
  - Serum creatinine, proteins and electrolytes
  - ECG
  - Pregnancy test, if applicable
  - Wound culture and sensitivity, if applicable

- **Treatment:**
  - Fluids either orally or intravenously (according to Parkland's formula)
  - High protein diet
  - Intravenous antibiotics
  - Topical treatment (either silver sulphadiazine or collagen application)
- **Observation:**
  - Pain score
    - Day1 Morning and Evening | | |
    - Day2 Morning and Evening | | |
  - Wound infection: Yes/No
  - Type of organism and antibiotic sensitivity
  - Duration of wound healing(days)
  - Whether Split Skin Graft (SSG) needed: Yes/No
- **Follow up :**
  - Development of contracture: Yes/No
  - Development of hypertrophic scar: Yes/No

MASTER CHART LEGENDS

M--MALE

F--FEMALE

IP--INPATIENT

D1--AVERAGE PAIN ON DAY1

D2--AVERAGE PAIN ON DAY2

SSG--SPLIT SKIN GRAFT

Y--YES

N--NO

MASTER CHARTS

SILVER SULPHADIAZINE GROUP

S.I. No.	NAME	AGE	SEX	IP No.	% of BURNS	D1	D2	INFECTION	HEALING TIME(DAYS)	NEED FOR SSG	CONTRACTURE	HYPERTROPHIC SCAR
1	SHANTHA	25	F	20407	5	2	1	N	16	N	N	N
2	VIVEK	10	F	2108	5	2	2	N	15	N	N	N
3	RAJEE	38	F	20943	5	2	2	N	18	N	Y	N
4	VIMALA	31	F	22542	5	2	2	N	17	N	N	Y
5	NANDHINI	8	F	2954	5	2	2.5	N	15	N	N	N
6	SHARMILA	17	F	26638	5	2	2	Y	24	Y	N	N
7	ABHISHEK	8	F	27899	5	2	2	N	16	N	N	N
8	PARTHIBAN	24	F	9548	5	2	2	N	15	N	Y	Y
9	AMSAVENI	36	F	31782	5	2	1	N	16	N	N	N
10	MATHIVATHANA	9	F	32567	5	2	2	N	15	N	N	N
11	PALRAJ	22	F	4214	5	2	2	Y	22	Y	N	N
12	RAJESHWARI	29	F	36547	5	2	2	N	16	N	N	Y
13	MANIKANDAN	35	F	37452	5	2	2	Y	23	Y	N	N
14	VINOTHINI	10	F	9864	5	2	2	N	16	N	N	Y
15	MURUGAN	35	F	1864	5	2	2	N	15	N	Y	N
16	SANGAMITHRA	30	F	43514	5	2	2	N	16	N	N	Y
17	KARPAGAM	22	F	44721	5	2	2	Y	15	N	Y	Y
18	SAROGINI	9	F	55216	5	2	2.5	N	14	N	N	N
19	NAGARAJ	21	F	47985	5	2	2	Y	23	Y	N	N
20	KANCHANA	28	F	981	5	2	2	N	16	N	N	Y
21	PANDIAMMAL	30	F	55426	5	2	2	Y	21	N	N	N
22	RANGARAJ	30	F	101591	5	2	2	N	16	N	N	Y
23	KRISHNAVENI	32	F	58421	5	2	2.5	N	15	N	N	Y
24	RISHWANA	28	F	12569	5	2	1	Y	22	Y	N	N
25	SATHYA	20	F	69751	5	2	1	N	16	N	N	N
26	MALLIKA	37	F	1890	5	2	2.5	N	16	N	N	N
27	THARANI	19	F	31895	5	2	2	Y	21	Y	N	N

28	MALARVIZHI	19	F	72546	5	2	2	N	15	N	Y	N
29	KAVITHA	20	F	33840	5	2	2	N	15	N	N	Y
30	KUMAR	27	F	67256	5	2	2.5	N	16	N	N	Y
31	RAMASAMY	28	F	54221	5	2	2	Y	22	Y	N	N
32	RANGANAYAKI	46	F	74215	5	2	2	Y	21	N	Y	N
33	PONNAMMAL	40	F	111349	5	2	2	Y	22	Y	N	N
34	VIJAYALAKSHMI	24	F	33456	5	2	2	N	15	N	N	Y
35	DHIVYA	22	F	88546	5	2.5	2	N	16	N	Y	N

COLLAGEN GROUP

S.I. No.	NAME	AGE	SEX	IP No.	% of BURNS	D1	D2	INFECTION	HEALING TIME(DAYS)	NEED FOR SSG	CONTRACTURE	HYPERTROPHIC SCAR
1	BACKIYALAKSHMI	35	F	42565	5	1	1	N	13	N	N	N
2	MRITHULA	8	F	2234	5	1	1	N	11	N	N	N
3	GANESAN	18	M	35522	5	1	1	N	13	N	N	N
4	KOMATHI	32	F	58452	9	1	1	N	14	N	N	Y
5	DHARMENDRA	10	F	7265	9	1	1	N	11	N	N	N
6	SAIKEERTHANA	24	F	1354	9	1	1	N	12	N	N	N
7	DHANALAKSHMI	9	F	43564	9	1	1	N	10	N	N	N
8	NETHRAVATHY	38	F	56821	9	2	1	Y	18	N	Y	Y
9	ASHWIN DAS	8	M	29214	9	1	1	N	11	N	N	N
10	RAMALAKSHMI	25	F	41983	9	1	1	N	13	N	N	N
11	SANDHYA	22	F	10981	9	1	1	N	12	N	N	N
12	RAJAMANI	24	F	57426	9	1	1	N	13	N	N	N
13	NANDHINI	21	F	101591	15	1	1	Y	20	Y	N	N
14	AKHIL	9	M	54421	15	1	1	N	12	N	N	N
15	THARA	34	F	12569	15	1	1	N	13	N	N	N
16	NATHIYA	36	F	69751	15	1	1	N	14	N	N	Y
17	MEGALA	22	F	67890	15	1	1	N	13	N	Y	Y
18	DHANVANTH	10	M	30899	15	1	1	N	12	N	N	N
19	ARTHI	26	F	52423	15	1.5	1.5	N	12	N	N	Y
20	VIJAYALAKSHMI	35	F	112462	15	1.5	1	N	13	N	N	Y
21	RAJESHWARI	45	F	69751	20	1	1	Y	19	Y	N	N
22	ANITH VINAY	27	M	11293	20	1	1	N	12	N	N	N
23	LATHA	21	F	31895	20	1	1	N	13	N	N	N
24	REGINA MARY	42	F	22407	20	1	1	Y	20	N	Y	Y
25	MAHESHWARI	17	F	62303	20	2	1	N	13	N	N	N
26	DHAVAMANI	19	F	28940	20	1	1	N	14	N	N	Y
27	MALLIKA	31	F	97542	20	1	1	N	12	N	N	N
28	NOORJAHAN	36	F	68319	20	1	1	N	13	N	N	Y
29	PUSHPHAMEENA	32	F	43638	20	1	1	N	13	N	Y	N

30	STELLA MARY	32	F	55899	20	1.5	1.5	N	12	N	N	N
31	MAHESHWARAN	27	M	19545	20	1	1	Y	21	Y	N	N
32	RAHUL	27	M	34782	20	1	1	N	13	N	N	N
33	MATHAN	27	M	91340	20	1	1	N	14	N	N	Y
34	RAJESHWARI	25	F	28981	20	1.5	1.5	N	14	N	Y	Y
35	NIRMALA	23	F	77569	20	1	1	N	13	N	N	N